436

Microline *

MODEL 555
KLYSTRON SIGNAL SOURCE

OPERATION AND SERVICE MANUAL

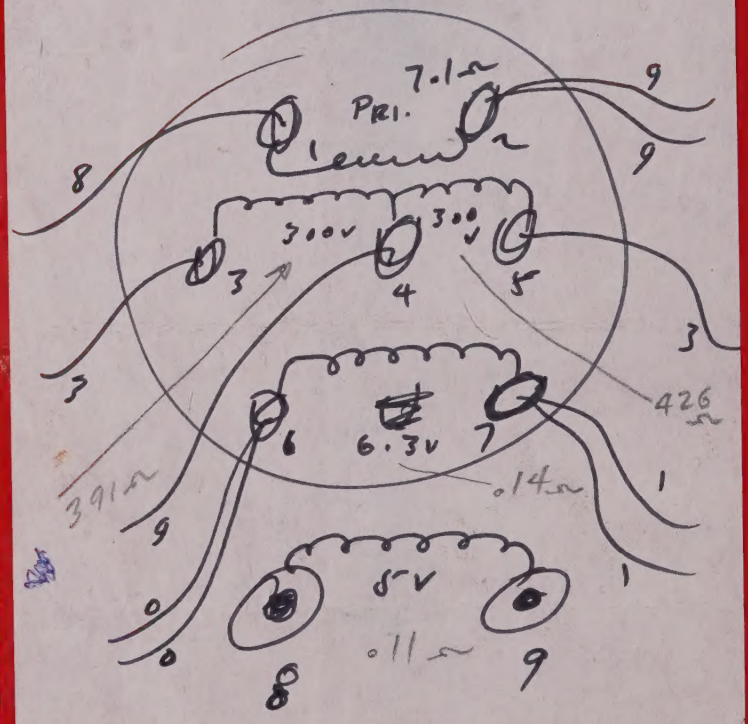
SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION
GREAT NECK, NEW YORK

PUBLICATION NO. 23-94A

MAY 1953

* Reg. Trade-Mark Of The Sperry Corporation

RATHEON


7.1Ω
PRI.
9
9
8
300V
300V
3
4
5
3
3
426Ω
6
6.3V
7
391Ω
.14Ω
1
9
1
0
0
8V
.11Ω
8
9

T103 Transformer
Sperry Part Number 672832
MFR = KTC
MFR DESIGNATION = S-26034

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WARNING

HIGH VOLTAGE is employed in this equipment. Operating personnel must observe all safety precautions to prevent loss of life.

1. NEVER change tubes or make adjustments inside the equipment while any section of the Signal Source is turned on.

2. ALWAYS disconnect or shut down the 115-volt power source before attempting to adjust or service the equipment internally.

3. EXTREMELY DANGEROUS POTENTIALS due to charges retained by capacitors, etc. may exist in the equipment after power shutdown. To avoid casualties always discharge and ground all circuits before touching them.

CAUTION

Under no circumstances should any air vent on the Model 555 cabinet be obstructed in such a way as to decrease or cut off the ventilation required for the normal operation of this instrument.

GENERAL SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

1. Input-Power Requirements

   a. Line-Voltage Range . . . . . 104 to 126 Volts
   b. Line-Frequency . . . . . 60 Cycles
   c. Phase . . . . . Single
   d. Maximum Power Consumption . . . . . 500 Watts

2. Klystron Electrode Output Voltages

   a. Beam . . . . . -250 to -3600 Volts below Ground
   b. Reflector . . . . . 0 to -1000 Volts below Cathode
   c. Control Electrode . . . . . 0 to -300 Volts below Cathode
   d. Output Voltage Stability. . . . . Within 0.025%
   e. Overload Selector . . . . . 0 to 15, 40, 60, and 120 Milliamperes

3. Modulator Output Voltages

   a. Sawtooth

      (1) Frequency . . . . . 600 to 1050 Cps
      (2) Amplitude . . . . . 0 to 300 Volts (peak-to-peak)

   b. Squarewave

      (1) Frequency . . . . . 600 to 1050 Cps
      (2) Amplitude . . . . . 0 to 300 Volts (peak-to-peak)

   c. Sinewave

      (1) Frequency . . . . . Same as Line Voltage
      (2) Amplitude . . . . . 0 to 300 Volts (peak-to-peak)

PHYSICAL CHARACTERISTICS

Overall Size

Height . . . . . 21-1/2 Inches

Depth . . . . . 15 Inches

Width . . . . . 19-1/4 Inches

Weight . . . . . 151 Pounds

Panel Finish . . . . . .Hammertone, Blue-Grey Enamel

MICROWAVE OSCILLATORS

Consult Tables I and II (pp 9 and 11) and applicable Data Sheets.

FIGURE 1-1 - MODEL 555 KLYSTRON SIGNAL SOURCE

SECTION I

GENERAL DESCRIPTION

1-1. GENERAL

The Model 555 Klystron Signal Source (figure 1-1) generates r-f power over a wide portion of the microwave spectrum - the output frequency being dependent upon the particular klystron chosen from a group of 45 applicable velocity-modulation tubes.*

The instrument is primarily designed for operation with all reflex oscillator klystrons whose electrode input requirements are covered by the output-voltage ranges provided by the Model 555 which incorporates voltage supplies for the klystron cathode (beam), reflector, control electrode and heater. The Beam Supply is continuously adjustable from -250 to -3600 volts. Beam currents of 120 milliamperes can be obtained up to -1250 volts, and 15 milliamperes up to -3600 volts. The reflector potential is continuously variable from 0 to -1000 volts, while the control electrode is continuously variable from 0 to -300 volts.

A Modulator within the instrument supplies output voltages of three commonly-used waveshapes by which amplitude or frequency modulation can be impressed upon the klystron signal. Provision is also made for the application of external modulation to the microwave signal, and for the synchronization between an external signal and the Modulator. A panel receptacle is included for observing the modulation waveshape on an oscilloscope.

Model 555 provides electronically-stabilized, klystron-electrode voltages which are continuously and smoothly variable.** A klystron d-c power cable and line-voltage input cord are supplied with the Signal Source.

1-2. APPLICATIONS

Model 555 Klystron Signal Source is a versatile instrument with many important microwave applications both in general systems work and in the precision measurements laboratory.

a. When operated without additional accessory equipment it can be used as:

(1) A microwave oscillator.

(2) A source of amplitude (squarewave) or frequency modulation (sawtooth or sinewave) for the klystron reflector electrode.

(3) A power supply where low-ripple and high-voltage stability are essential.

* Klystron tubes are not furnished as integral components of the Model 555, but are purchased separately.

** Except for the heater voltage, which is fixed and unregulated.

b. When operated in conjunction with other equipment it can be used for:

(1) The measurement of:

(a) Impedance of microwave transmission lines and components.

(b) Attenuation of microwave components.

(c) Power level of microwave signal generators.

(d) Microwave frequency response and bandpass characteristics.

(e) Sensitivity of microwave receivers.

(2) A local oscillator in experimental microwave television, communication and other systems.

(3) A modulated signal source for spectrum analysis.

(4) The alignment and testing of microwave receivers.

(5) A microwave oscillator providing the transmitter signal for experimental systems work such as required for beacons, doppler radar, MTI radar, microwave relays, and television.

1-3. DESCRIPTION OF INSTRUMENT

The Model 555 Klystron Signal Source is enclosed within a blue-gray, Hammertone-finish steel cabinet. All operating controls, meters, external connectors, switches and fuses are located on the front panel (fig. 1-1).

The instrument contains two separately removable decks comprising a set of four power supplies (which provide the klystron d-c electrode voltages), a d-c reference-voltage source, a servo-regulator unit and motor, and a versatile modulation-voltage source with its separate power supply. An insulated interconnecting cable completes the input and output circuits between the two decks. Both decks are of the proper size for installation in standard 19-inch relay racks should this become necessary.

The Model 555 cabinet is fitted with top and rear doors for access to the chassis interconnecting cable, certain adjustments and some of the replaceable components. An interlock switch automatically de-energizes the entire instrument when the rear door is opened. Side louvers and grillework on the cover and rear door are provided to insure adequate ventilation for the complete equipment contained within the two decks. It is recommended that no obstructions be placed over or near these cooling vents at any time while the instrument is being operated.

The physical dimensions and weight of the instrument (refer to General Specifications, page vii) are convenient for bench operation. A large handle on each side of the cabinet aids in relocation of the unit as required.

1-3a. BEAM-SUPPLY DECK

The beam-supply deck, shown in figure 1-2, is the lower of the two chassis in the instrument. This voltage supply provides negative potentials for klystron cathodes

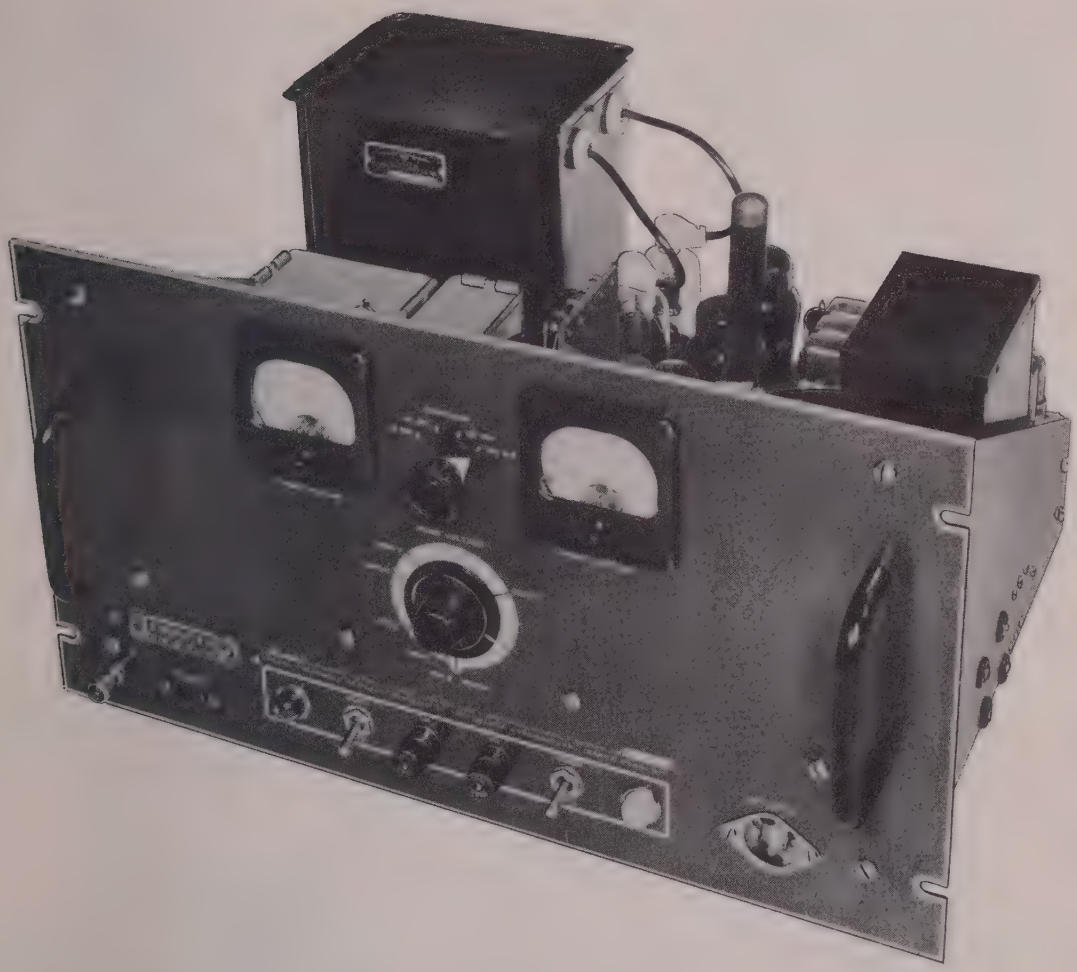

FIGURE I-2 - MODEL 555 BEAM-SUPPLY DECK

over a 3350-volt range (from -250 to -3600 volts) enabling operation of low-voltage (300-volt type) klystrons, as well as those of the high-voltage, low-current type.

(1) Primary Power Requirements

A single-phase input voltage of 115V ± 10% is required. Line frequency must be 60 cycles per second. Maximum power consumption is approximately 500 watts at 82% power factor. The POWER switch (S-101) and fuse F-101, both located on the panel of the beam-supply deck, control the primary input to the entire instrument. A white pilot lamp (I-101) located to the right of the POWER switch indicates the application of input voltage to both decks.

(2) Beam Supply

The Beam Supply provides smooth, hum-free cathode voltages from -250 to -1250V (0 to 120 ma), and from -1250 to -3600V (0 to 15 ma). Voltage adjustments are performed

with a single control knob. Over this entire range the d-c output is electronically regulated for line-voltage changes of ±10% and for load variations from 0 to 120 ma and from 0 to 15 ma, respectively. Ripple voltage is less than 10 millivolts rms. Meters for beam voltage and current are located to the left and right above the BEAM VOLTAGE control knob.

Between the pair of panel meters the OVERLOAD range-selector switch is provided for the purpose of protecting the klystrons from the damaging effects of excessive beam currents, if they happen to be applied inadvertently to the microwave tube. A 30-second time-delay relay (K-105) is incorporated into the circuit to allow an initial warm-up period for the klystron heaters, as well as those in the rest of the instrument.

The Beam Supply is designed to have its positive at ground potential (the klystron shell). Temporary shut-off and instant return of the beam voltage is accomplished by means of the BEAM toggle switch (S-102A). A red pilot lamp (I-102) directly to the left of the BEAM switch indicates application of beam voltage. A 5-ampere fuse (F-102) prevents damage to the supply due to overloading.

The front panel of the beam-supply deck also includes a recessed panel connector for the 115V input, the klystron d-c power receptacle, a 115V receptacle for the klystron blower cable and a terminal post for grounding the entire instrument.

(3) Klystron D-C Power Cable

This cable is furnished as accessory equipment with the Model 555 Signal Source (refer to figure 1-3). The cable couples the d-c output of both the beam-supply and modulator-reflector decks to the klystron tube chosen for operation.

CAUTION

1. If it becomes necessary to alter the tube socket wiring or to use adapter sockets for special applications, circuit tie-points should not be made on unused pins because internal tube connections might be shorted thereby with resulting damage to the power supply or the klystron.

2. Where it may become necessary to change socket wiring in special applications, one side of the heater should be connected directly to the cathode contact on the tube socket - not via a heater lead in the cable.

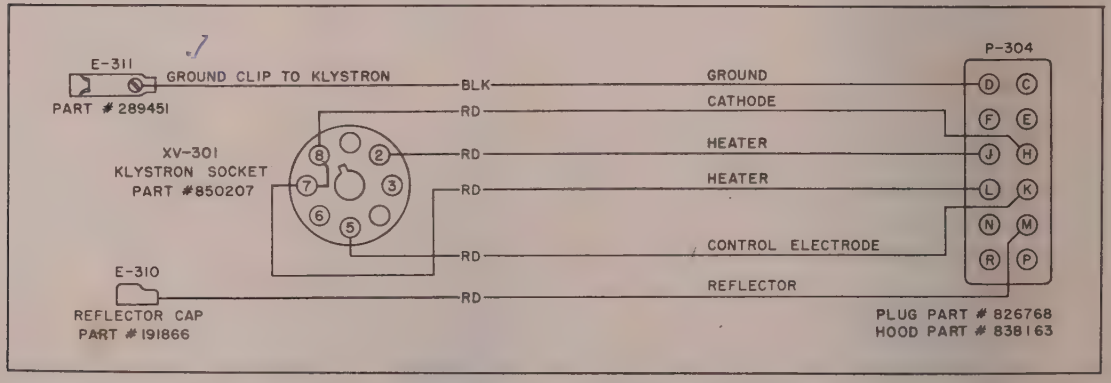

FIGURE 1-3 - MODEL 555 KLYSTRON D-C POWER CABLE - SCHEMATIC DIAGRAM

At one end of the cable a Winchester fitting (P-304) plugs into a mating receptacle at the lower left of the beam-supply panel. At the opposite end of the cable a tube socket (XV-301) mates with the base pins of the klystron. The B+ lead is terminated in an alligator clip which provides a good ground connection when securely fastened to some convenient point on the klystron shell. The reflector lead terminates in an insulated ceramic cap which mates with the reflector electrode of Sperry reflex klystrons. When velocity modulation tubes of manufacturers other than Sperry are employed, it may be necessary to make up adapter collars for insertion in the ceramic reflector cap or to alter tube socket (XV-301) connections. Always check klystron pin connections versus cable-socket connections before attaching socket XV-301 to the klystron.

I-3b. MODULATOR-REFLECTOR DECK

The modulator-reflector deck (refer to figure 1-4) is located in the upper part of the cabinet directly above the beam-supply deck. In addition to the Reflector Supply and the Modulator and its power supply, the upper deck contains a separate source of variable control-electrode voltage and an a-c source to power the klystron heaters. All controls are grouped on the front panel according to function.

(1) Primary Power Requirements

The primary input power is introduced by way of the beam-supply deck where a single-phase input voltage of 115V ±10% is applied for the entire instrument. POWER switch S-101 and fuse F-101, located at lower-right center of the beam-supply deck, control the primary input to both decks. A white panel lamp (I-101), located to the right

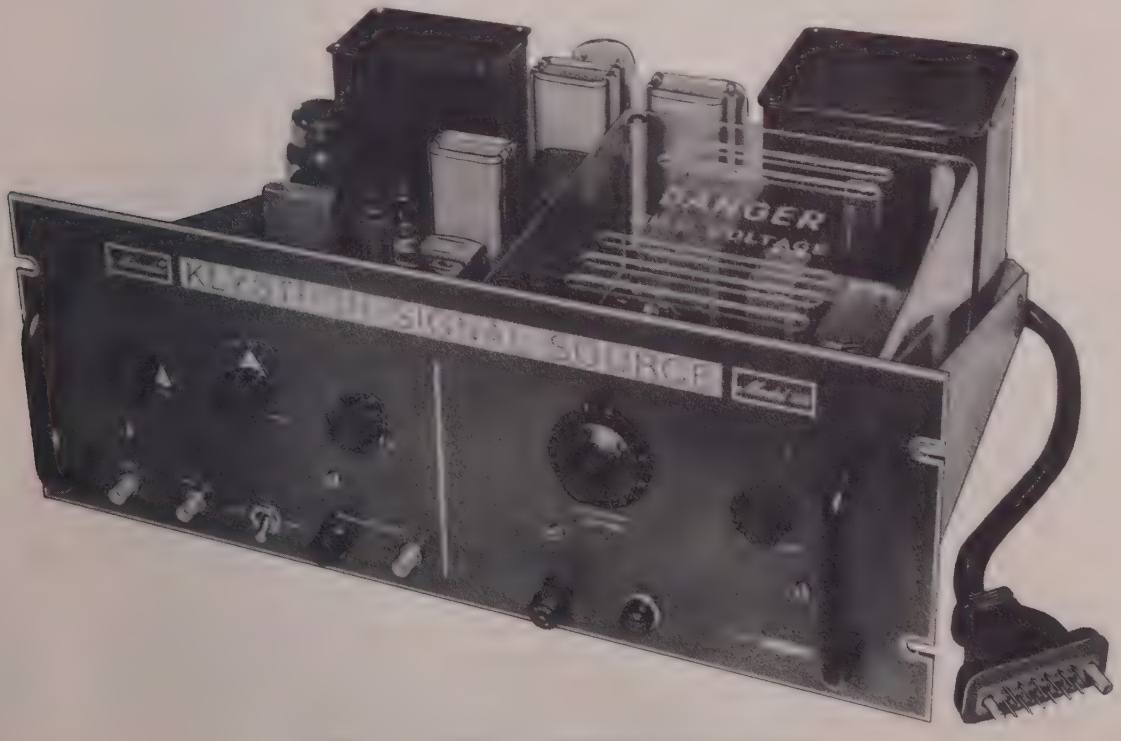

FIGURE 1-4. MODEL 555 MODULATOR-REFLECTOR DECK

of the POWER switch, indicates the application of primary input voltage to both decks. A red panel lamp (I-201), located below the REFLECTOR VOLTAGE control, glows when the upper deck has been energized.

(2) Modulator

The Modulator furnishes output voltages in any one of three distinct waveshapes most commonly required for microwave measurements. Squarewave, sawtooth or sinewave modulation is impressed upon the klystron reflector voltage through a coupling capacitor (C-206). The desired type of modulation is selected by means of the three-position WAVESHAPE control switch.

The output waveshape, frequency and amplitude controls of the Modulator are grouped together on the left half of the panel above three BNC receptacles, a toggle switch, and a separate amplitude control for adjusting the magnitude of the Modulator output signal at the MODULATION OUT panel receptacle. This receptacle is provided for coupling part of the Modulator output to an oscilloscope in order to observe and analyze the signal being applied to the klystron reflector electrode. The toggle switch permits the application of either internal or external modulation to the reflector of the tube.

Both the sawtooth and squarewave modulation can be tuned to any frequency in the range between 600 and 1050 cps by means of the FREQUENCY panel control. The sinewave modulation, however, is fixed at the frequency of the primary input voltage (60 cps.). The amplitude of each of the three available types of modulation is continuously variable from 0 to 300V peak-to-peak by means of the AMPLITUDE panel control.

The squarewave output is characterized by a flat top and bottom, with a maximum rise and fall time of five microseconds. The sawtooth decay time does not exceed 15 microseconds.

The BNC panel fitting farthest to the left is the SYNC. receptacle (J-201). It is provided for synchronizing an external oscilloscope to the Modulator trigger signal or for synchronizing the Modulator to an external sweep generator. The SYNC. receptacle is coupled by means of capacitor C-211 to the blocking-oscillator sweep circuit in the Modulator. The MOD. IN receptacle (J-202) permits direct modulation of the klystron reflector voltage by an external source.

The Modulator has its own self-contained, regulated power supply which provides the required voltage and current for the waveshaping circuits. Modulator output voltage is automatically available when the POWER switch (S-101) is thrown on. The circuit is closed when the white pilot light (I-101) on the panel of the beam-supply deck and the red light (I-201) on the reflector-deck panel are illuminated.

(3) Reflector Supply

The Reflector Supply provides smooth, continuous variation of the reflector voltage from 0 to -1000V referred to the klystron cathode. The d-c output voltage is electronically regulated to permit a maximum variation of only 0.02% for a 10% change in line voltage. The ripple is less than 5 mv (rms).

Voltage adjustments are made with a calibrated dual-control knob. The larger dial reads in 100-volt steps, and the smaller dial is calibrated in units. The Reflector Supply is energized when the POWER SWITCH (S-101) on the lower deck is thrown on. Illumination of the white pilot lamp (I-101) on the lower deck and the red lamp (I-102) on the upper deck indicates that the Reflector Supply is energized.

(4) Control-Electrode Supply

A single knob at the right of the panel varies the control-electrode voltage smoothly from 0 to -300V with respect to the negative output of the Beam Supply (cathode potential). Line-voltage fluctuations of 10% are regulated so as to produce not more than 0.02% variation of the d-c output potential. Ripple voltage is less than 0.05V (rms).

No metering is provided because the control electrode is customarily adjusted in a negative direction until the klystron beam current is set within the proper operating range for the particular klystron being used. In this way the BEAM CURRENT meter serves to indicate optimum control-electrode voltages.

The Control-Electrode Supply is energized when the POWER SWITCH (S-101) is thrown on. Both the white and red pilot lamps indicate the application of control-electrode voltage.

(5) Heater Supply

The klystron heater is supplied directly from a 6.3V, 2amp, 60-cycle transformer (T-201, terminals 10 and 11). Output is unregulated and no metering is provided. One side of the heater-supply output voltage is tied to the negative of the Beam Supply (cathode) at the klystron socket. The Heater Supply is insulated to withstand maximum beam-supply potentials.

Heater-supply voltage is applied when the POWER switch (S-101) is thrown on. The circuit is closed when both the white and red pilot lamps are lighted.

1-4. APPLICABLE MICROWAVE OSCILLATORS

1-4a. GENERAL

The Model 555 Klystron Signal Source is designed for operation with any of the 45 standard types of reflex-oscillator klystrons listed herein. Optimum performance cannot be expected from this instrument unless the user thoroughly familiarizes himself with the specific electrical characteristics, tuning techniques, and operating procedures for the particular klystron to be used before attempting to obtain a microwave signal from it.

Therefore, a study of the electrical characteristics and special requirements must be made initially by reference to the applicable klystron data sheet prior to the installation of any tube for operation with the Model 555 Signal Source. In the case of Sperry tubes the data sheet is enclosed with the klystron at shipment, or - if necessary - it can be obtained by request from the Special Electronics Department, Sperry Gyroscope

Company. Refer to Paragraphs 2-1, 2-2 and 2-3 of this manual for detailed general information on klystron operating characteristics, tuning procedures and installation. While these paragraphs give specific coverage for Sperry Klystrons, much of the description applies in general to all reflex types.

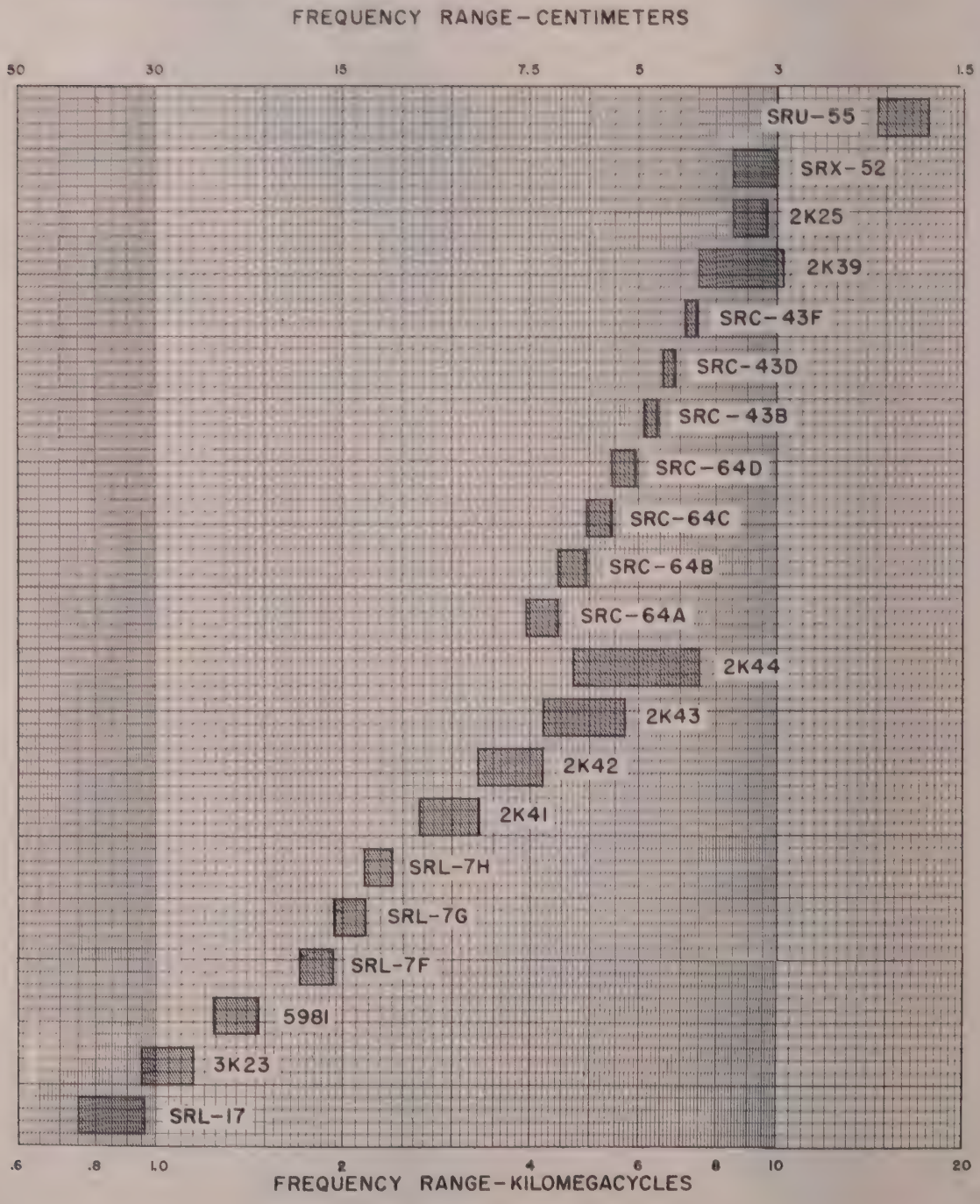

FIGURE 1-5 - SPERRY REFLEX KLYSTRON SPECTRUM CHART

Maximum voltage ratings should be observed at all times since this instrument is capable of exceeding the voltage and current ratings of some of the klystrons which may be operated with it. USE CAUTION.

A cooling blower must always be used for klystron beam-power inputs in excess of ten watts. The use of a blower is also desirable at lower input powers in order to obtain maximum output stability and minimum frequency drift. The airstream should be directed to provide optimum dissipation of heat from the klystron under operation. It is always advisable to shock-mount the blower-motor assembly so as to minimize the possibility of vibration modulation effects on the klystron.

1-4b. APPLICABLE SPERRY REFLEX KLYSTRONS

Twelve Sperry Klystron types are available* for operation with the Signal Source. These tubes are listed in Table I which summarizes the frequency coverage, nominal microwave output power, tuner type (where required) and the reference designation for the technical data sheet on each klystron type. For ready reference the spectrum chart shown in figure 1-5 gives the operation bandwidth of the Sperry reflex klystrons in terms of both wavelength and frequency.

TABLE I

SPERRY REFLEX KLYSTRONS USED WITH MODEL 555

KLYSTRON SIGNAL SOURCE

Klystron Type	Frequency Range (Kmc)	Nominal C-W Output Power (Watts)	Sperry Tuner[1] Model	Klystron Data Sheet-Sperry Publication No.
SRL-17	0.750 - 0.960	1.00	--	23-1831
3K23	0.950 - 1.150	1.00	14	15-5660201
5981	1.245 - 1.460	0.10	--	To be announced
SRL-7F	1.700 - 1.930	5.00	--	" "
SRL-7G	1.930 - 2.160	5.00	--	" "
SRL-7H	2.160 - 2.400	5.00	--	" "
2K41[2]	2.660 - 3.310	0.25	--	15-660472
2K42	3.300 - 4.200	0.25	12	15-5660253
2K43	4.200 - 5.700	0.25	12	15-660256
2K44	4.700 - 7.500	0.25	12	15-5660255
SRC-64A[3]	3.950 - 4.450	1.50	--	To be announced
SRC-64B[3]	4.450 - 4.950	1.50	--	" "
SRC-64C[3]	4.950 - 5.430	1.50	--	" "
SRC-64D[3]	5.430 - 5.930	1.50	--	" "
SRC-43B[3]	6.125 - 6.425	1.00	--	23-2015
SRC-43D[3]	6.575 - 6.875	1.00	--	"
SRC-43F[3]	7.125 - 7.425	1.00	--	"
2K39	7.500 - 10.300	0.25	12	15-5657105
2K25	8.500 - 9.660	0.03	--	To be announced
SRX-52[3]	8.500 - 10.000	0.05	--	" "
SRU-55[3]	14.500 - 17.500	0.03	--	23-2023

- - - - - - -

[1] Tuners not furnished unless noted otherwise. Purchase these items separately.

[2] This klystron type is furnished as a complete unit with a special full-range tuning device. The component cannot be purchased separately.

[3] Integral tuner - waveguide flange output terminal.

- - - - - - -

* All klystrons must be purchased separately.

1-4c. OTHER APPLICABLE KLYSTRONS

Table II covers 35 additional types of reflex velocity-modulation tubes currently obtainable from other manufacturers. The frequency ranges and output power are given for each. The Model 555 is also recommended for use with other similar tubes whose characteristic operating voltages and currents fall within the range of this instrument.

1-5. ACCESSORY EQUIPMENT REQUIRED BUT NOT SUPPLIED

In order to operate the Model 555 with applicable klystrons, certain accessories not furnished with the unit are necessary. A list of the basic required equipment follows:

(1) Primary power source capable of delivering 500 watts (80-percent power factor) at 115 volts, 60 cycles, single phase.

(2) Suitable klystron mounting fixtures, and required accessory interconnection fittings and cables.

(3). Motor and blower unit for cooling the klystrons. Blower should have a minimum output rating of 100 cu. ft./min. Motor power cord connects to 115V-Blower output receptacle on beam-supply deck panel.

(4) Microwave components: Includes a klystron oscillation indicator, a suitable impedance-matching device for obtaining optimum klystron r-f output, and means for monitoring microwave-signal frequency and power.

Figure 1-6 shows a typical measurement setup with the Model 555 powering a reflex klystron which is feeding a microwave signal into a waveguide transmission line which includes components for monitoring oscillation, VSWR, and signal frequency. In this case a tuned audio amplifier (right-hand cabinet) is used as an indicator with a squarewave (pulsed) modulated microwave signal.

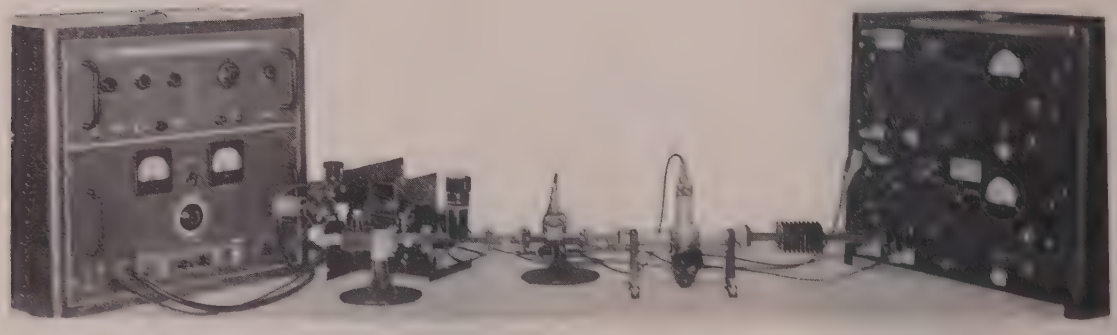

FIGURE 1-6 - MODEL 555 WITH TYPICAL BENCH SETUP

TABLE II

OTHER STANDARD KLYSTRON TYPES FOR USE WITH
MODEL 555 KLYSTRON SIGNAL SOURCE

Klystron Type	Frequency Range (Mc)	Nominal C-W Output Power (Watts)
2K22	4240-4910	.075
2K26	6250-7060	.080
2K28	1200-3750*	.140
2K29	3400-3960	.085
2K33	22,000-25,000	.010
2K48	4,000-11,000*	.005-.020
707B	1200-3750	.140
726C	2700-2960	.100
QK157	3700-4000	----
QK159	2950-3275	.175
QK205 (5721)	2,000-12,000	.160
QK258	8500-9660	.020
QK289 (QK277)	27,270-30,000	.020
QK290 (QK140)	29,700-33,520	.020
QK291 (QK141)	33,520-36,250	.018
QK292 (QK142)	35,100-39,700	.005
QK293 (QK226)	37,100-42,600	.005
QK294 (QK227)	41,700-50,000	.005
QK295	50,000-60,000	----
QK306	18,000-22,000	.010
QK318	5400-6000	----
6BL8	1600-6500*	.200
5650	1245-1460	.134
5976	6250-7420	.085
6043	2950-3275	.150
X12	12,400-17,500	.030
X13	8,200-12,400	.250
X21	9,100-11,000	5.000
X26	5925-7725	1.000-.025
V23	9,100-11,000	5.000
V27	9,100-11,000	5.000
V53	10,700-11,700	.050
V54	10,500-12,200	.100
V55	8,200-11,500	.600
V58	8,500-10,000	.620
V62	9,100-11,000	8.000
V63	8500-9400	8.000
V260	8,500-10,000	.015
V270	8,500-10,000	.015
V280	8,500-10,500	.012
V290	8,500-10,500	.012

- - - - - - -

* Determined by characteristics of external cavity.

SECTION II

OPERATION

2-1. GENERAL

Proper operation of the klystron selected for a desired signal frequency (Table I, p. 9 can only be realized if the operator fully acquaints himself with the characteristics and requirements of the particular tube chosen. This information is available in detailed form in the Sperry Klystron Data Sheets listed in Table I. These sheets cover the general and specific considerations involved in the proper operation, selection of electrode voltages, installation, application, tuning, and modulation of Sperry klystrons. The instructions therein should be closely followed not only to obtain optimum tube performance, but to avoid damaging the klystrons.[1]

2-2. KLYSTRON OPERATING CHARACTERISTICS

In addition to the reference material mentioned above, further operational information is given in the following paragraphs to provide a better understanding of the klystron tuning and alignment techniques required to obtain satisfactory operation and optimum performance from the Model 555 Klystron Signal Source at desired frequencies and power levels.

2-2a. MECHANICS OF TUNING THE KLYSTRON RESONATOR - COARSE ADJUSTMENT AND VERNIER TUNING

Mechanical tuning of the reflex-klystron resonator is accomplished by varying the spacing between the tube mounting flanges. Each of these two flanges is parallel to a corresponding klystron grid within the resonant cavity of the tube, and optimum beam penetration is only possible when the horizontal planes of these grids are normal to the common vertical centerline of the electron beam. For this reason the mounting flanges must be kept approximately parellel at all times.

The spacing between the pair of klystron grids controls the output-signal frequency of the tube. Oscillation at the low-frequency end of the range occurs when the grid spacing is small; conversely, output frequency rises toward the high-frequency edge of the band as the grid spacing increases. The grid spacing is non-linear with respect to frequency; i.e. for the same linear displacement, the frequency shift is much more rapid when the grids are close than when they are further apart.

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[1] In this section of the Model 555 Manual specific reference is made to Sperry klystron types only. However - in a general way - the remarks apply to most velocity-modulation tubes. In the case of any klystron, always ascertain the beam current which will be drawn at the operating voltage to be used, so that the proper overload range can be set on the Model 555 control panel. It is equally important to check the tube socket connections to determine the necessity for making an adapter for the standard klystron d-c power cable furnished with the equipment.

The klystron signal frequency is given a coarse adjustment by changing the length of the three tuning struts which separate the mounting flanges. Clockwise rotation increases frequency; counterclockwise rotation decreases frequency. Vernier control of the microwave-signal frequency is accomplished by rotation of the knob on the klystron tuner. The knob actuates the lever arm (supplied with the klystron) which lengthens or shortens the effective length of one tuning strut. The direction of tuner-knob rotation controls frequency in the same manner as previously described for the coarse tuning struts. Figure 2-1 shows a typical reflex klystron and tuner ready for preliminary alignment.

2-2b. PRELIMINARY ALIGNMENT OF MOUNTING FLANGES

In the interest of preventing damage to tubes and decreasing the required tuning time after the application of electrode voltages, it is always advisable, whenever possible, to adjust the mounting flanges for parallel alignment and proper spacing within the tuning-range limits before the klystron is assembled to the tuner for installation as a plug-in unit.

Extreme care is necessary during this operation because satisfactory electrical performance and maximum tube life are closely related to the application of proper klystron tuning techniques.

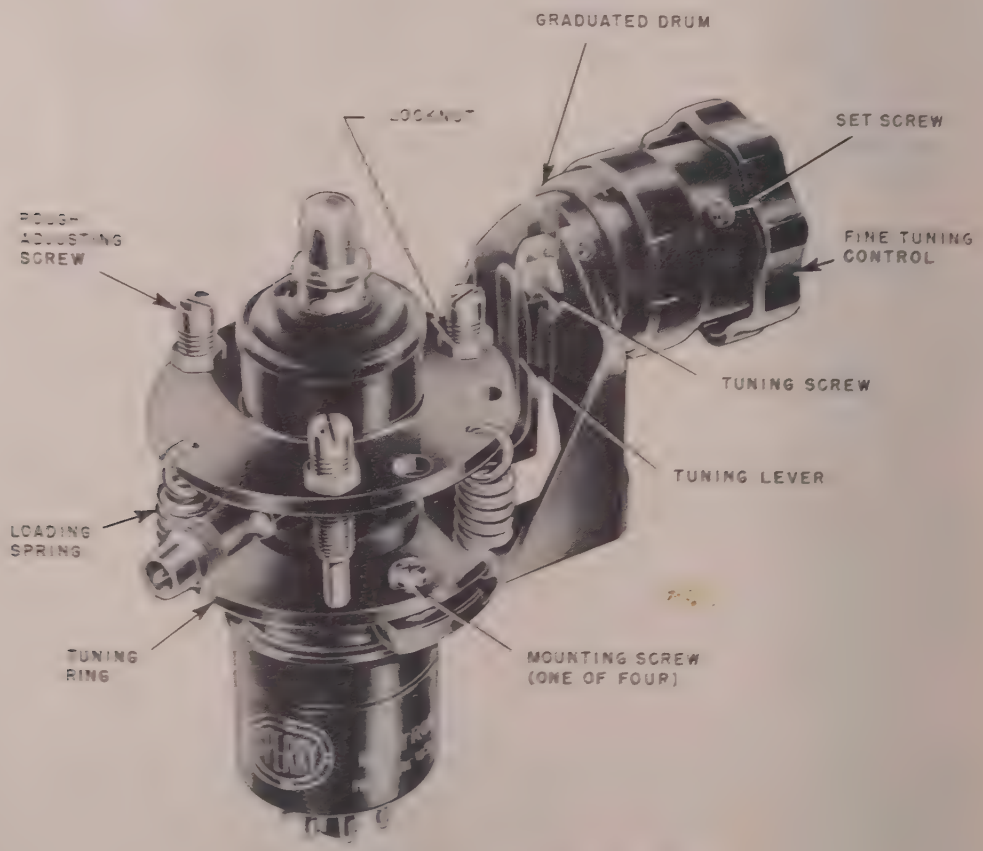

FIGURE 2-1 - REFLEX KLYSTRON AND TUNER

SECTION II — OPERATION

The data sheet for most Sperry reflex klystrons gives the nominal spacing which exists at mid-frequency[1] between the outer edges of the pair of mounting flanges (refer to tube dimension "A" in the applicable data sheet). This distance is readily measured with a micrometer or ruler to give a broad approximation of resonator frequency, and the adjustments required for tuning to any desired part of the range. The full tuning range of the tube can usually be covered by changing the flange spacing by a few hundredths of an inch. Refer to the applicable data sheets for specific values.

Before installing a klystron in its tuner the following procedure is recommended:

> NOTE
>
> This procedure applies only to those Sperry klystron types furnished separately, and designed for assembly to either the Sperry Model 12 or 14 Tuner after shipment from the factory. Klystrons requiring preliminary alignment include Types 2K39, 2K42, 2K43, 2K44, and SRX-16[2].

(1) Measure mounting-flange separation at three equally-spaced points on the circumference. Any appreciable difference in the individual readings in a set indicates that undesirable cocking of the resonator diaphragm is present, and that the mounting flanges are not parallel.

(2) Refer to the applicable data sheet for the required "A" dimension, and its variation over the specified tuning range of the particular klystron.

(3) Apply the information gained in the preceding steps (1) and (2), align the flanges by screwdriver adjustment of the tuning struts in small steps (do not exceed 90-degree rotation of any screw at one time) until the flange spacing is approximately equal at any point measured, and is within the published range for the "A" dimension.

(4) After assembly to the proper tuner, the tube is now ready for installation.

By conforming to the recommended preliminary alignment, the following major klystron-tuning errors and resultant tube damage may be avoided:

(1) By determing comparative klystron-grid separation from a measurement of mounting-flange spacing, and reference to the data sheet specification for the "A" dimension, contact damage between the grids can be prevented by avoiding any further counter-clockwise strut rotation when the resonator grids are already very close at the start of tuning.

(2) In the same way, measured mounting-flange spacing close to the upper end of the published range indicates that subsequent adjustment for higher frequencies must

- - - - - - -

[1] New tubes are factory pre-set to the approximate mid-point of the published tuning range.

[2] Sperry Type 2K41 is factory-aligned and permanently assembled to a full-range tuner designed to maintain required flange alignment automatically at all settings. Types 3K23 and 3K27 are removable from the Model 14 Tuner, but are provided with an integral tuning arrangement similar to that of Type 2K41. In no instance should the sealed tuning-strut adjustment be altered on any of these three klystron types.

be made with extreme caution to avoid overstretching and cracking the diaphragm with irreparable damage to the tube.

2-3. KLYSTRON INSTALLATION

> WARNING
>
> Before installing any klystron, make certain that: (1) both BEAM and POWER switches are off, (2) the proper klystron socket connections have been provided.

The type of tuner for each klystron is listed in Table I, p. 9. The klystron should be securely mounted to the tuner with four broad-head screws which fasten the lower tube-mounting flange to the mating flange of the tuner (refer to figure 2-1). Sperry Klystron Type 2K41, which is permanently attached to a special full-range tuner assembled at the factory, will only require final assembly to a mounting panel for installation. With the exception of the Type SRC-43 Sperry waveguide output klystrons, whose tuners are an integral part of the tube, the other klystrons in the group are assembled to either the Model 12 or 14 Tuner in a similar manner. (See Table I, p 9.)

Klystron Types 3K23 and 3K27 are supplied with a retainer wire which limits the movement of the tuning lever arm and thereby prevents the Fulrange tuning device, which is an integral part of these tubes, from becoming disassembled when the tubes are not secured to the Model 14 Tuner. It is, therefore, always important to have this retainer in place when the type 3K23 or 3K27 klystron is out of the tuner, and also when the tuning knob is removed for installation on a mounting panel. However, once tube and tuner have been assembled to the mounting panel, and the tuning knob has been rotated until the lever arm is operating normally, the retainer ring should be slipped over the resonator and allowed to hang loosely. Unless this is done, the tuning range of these tubes will be unnecessarily restricted and the full specified frequency range of the klystron signal cannot be realized.

To install the Model 12 Tuner on a mounting panel, first remove the tuning knob and threaded shaft from the tuner by counterclockwise rotation. Then attach the tuner bracket and tube[1] to the inside surface of the panel, using a pair of clearance holes drilled directly below a centrally-located 3/8-inch hole. Reassemble the tuning knob to the tuner by inserting the shaft through this central hole from the front of the panel.

The tube socket on the klystron d-c power cable (refer to figure 1-3) adapts directly to the twelve Sperry klystron types listed in Table I, p. 9. After installation of the tube, plug this socket to the klystron base. If it is desired to operate klystrons or similar tubes other than those of Sperry manufacture, always check tube pin connections against those of the tube socket (fig. 1-3) and make socket wiring alterations only as recommended in Paragraph 1-3a(3).

After connecting the base of the tube to the cable socket, ground the klystron shell to the B+ side of the Beam (high-voltage) Supply. The ground lead is terminated in

- - - - - - -

[1]Only after preliminary klystron mounting-flange alignment in the case of certain klystrons, as previously described. (See Paragraphs 2-2a and 2-2b.)

an alligator clip which is to be fastened to the nearest klystron tuning strut or tuner mounting screw on the klystron mounting flange (remove all paint at any contact point chosen for grounding the B+ lead).

The reflector lead from the klystron d-c power cable is then coupled to the klystron reflector cap. In case of accidental contact by the operator, a ceramic cap provides the required insulation from the dangerously high voltages existing at this electrode as soon as the Model 555 POWER switch is in the ON position. Never attempt to operate a klystron without providing adequate insulation at the reflector electrode.

Plug an a-c line for a suitable blower motor into the BLOWER receptacle provided on the front panel of the instrument. Although a cooling airstream is not required for klystrons operated at a beam-power input of less than ten watts, temperature stability will be improved considerably if a blower is used at all times.

The klystron is now ready for the application of controlled electrode voltages to be furnished from the Model 555 Signal Source. Never change klystrons or touch connections when the instrument is turned on.

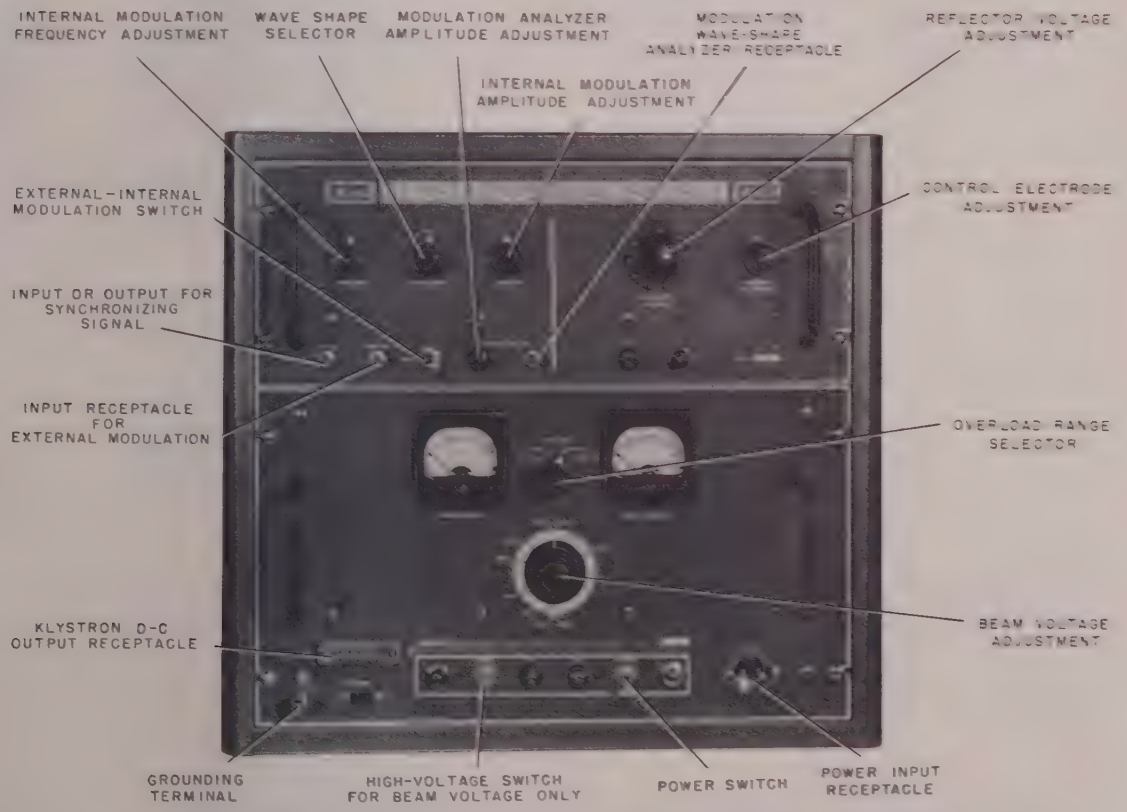

FIGURE 2-2 - MODEL 555 KLYSTRON SIGNAL SOURCE - CONTROL PANEL

2-4. FUNCTIONS OF CONTROLS

All the controls and meters for the Model 555 are located on the front panel of the instrument (refer to figure 2-2).

The controls fall into two main subdivisions: Those which govern the power supplies furnishing the klystron electrode voltages, and those controlling the modulation to the reflector electrode of the klystron.

The function of each control associated with the klystron-electrode power supplies and the Modulator is tabulated below.

2-4a. POWER SUPPLY CONTROLS

Panel Designation	Description	Function
1. POWER	Toggle Switch	Controls line-voltage input to entire instrument as well as SLOWER receptacle. Applies heater, reflector, and control-electrode voltages to klystron. Operates time-delay relay. White pilot lamp on front panel indicates application of 115V a-c input voltage.
2. BEAM	Toggle Switch	Controls beam-supply output voltage ONLY. Does not operate the time-delay relay. Red pilot lamp to left of switch lights when the beam voltage is ON.
3. BEAM VOLTAGE*	Applies to both the Control Knob and Beam Voltage Meter	Clockwise rotation of knob increases beam voltage over calibrated range from -250 to -3600V with respect to ground (shell of klystron). Red pilot lamp on beam panel lights when the beam voltage is ON.
4. OVERLOAD	Selector Switch	Sets overload relay to de-energize Beam Supply when beam current exceeds any one of four settings.
5. REFLECTOR VOLTAGE	Calibrated Dial Knob	Adjusts voltage supplied to reflector electrode over range from 0 to -1000V with respect to applied beam voltage. Dial is calibrated linearly in volts. Clockwise rotation increases voltage applied.
6. CONTROL ELECTRODE	Panel Knob	Adjusts control-electrode (bias) voltage from 0 to -500V with respect to applied beam voltage. Clockwise rotation increases voltage. White pilot lamp on Beam Supply and red lamp on upper panel glow when control-electrode voltage is ON.

* CAUTION - Never turn on the BEAM switch before checking that the BEAM VOLTAGE control knob has first been adjusted for a value not exceeding the maximum voltage to be used for the klystron beam.

2-4b. MODULATOR CONTROLS

NOTE

The POWER toggle switch controls input voltage to all Modulator circuits. Illumination of the white pilot lamp on the Beam-Supply deck and the red lamp on the Modulator-reflector deck indicates that the Modulator is ON.

Two BNC fittings, the SYNC. and MOD. IN jacks, are located on the Modulator panel below the control knobs. The SYNC. receptacle serves as a convenient connection

point for introducing or extracting synchronizing pulses between an external device and the Modulator blocking-oscillator transformer. With the EXT.-INT. switch on EXT., the MOD. IN receptacle is used to couple the Klystron reflector electrode to an external modulation signal thereby disconnecting the Model 555 Modulator from the circuit.

Panel Designation	Description	Functions
1. EXT. - INT.	Toggle Switch	Connects reflector-electrode circuit to either the internal Modulator or to receptacle for external modulation.
2. WAVE SHAPE	Selector Switch	Varies reflector-electrode voltage output of internal Modulator - either square, sawtooth or sinewave voltage.
3. FREQUENCY	Panel Knob with Pointer	Adjusts internal modulation frequency over range from 800 to 1650 cps. Clockwise rotation INCREASES frequency. This control has NO effect, however, on the sinewave modulation frequency which is equal to that of the 60-cycle line.
4. AMPLITUDE	Panel Knob with Pointer	Adjusts amplitude of square, sawtooth and sinewave modulation over the range from 0 to 300 V peak-to-peak. Clockwise rotation increases amplitude.
5. MODULATION OUT	Applies to both the Panel Knob and the Panel Receptacle	Knob varies amplitude of modulation output signal available at MODULATION OUT panel receptacle located directly below the panel designation

2-5. OPERATING PROCEDURE

2-5a. STARTING PROCEDURE

The operating procedure for obtaining a desired klystron signal within the frequency range covered by this instrument involves several important steps which must be performed in the proper sequence if optimum results are to be obtained and damage to the unit or loss of life prevented.

Section II has thus far outlined (1) the essential klystron information needed for the proper choice of tube, tuner and electrode voltages; (2) the operations and mechanical considerations involved in tuning the klystron resonator before and after assembly to the tuner; (3) the importance of preliminary alignment of the klystron mounting flanges in certain tubes where this is not automatically taken care of; (4) the precautions surrounding the "A" dimension and the absolute necessity of maintaining this dimension within the specified tuning range of the particular klystron; (5) the proper procedure for coupling the input-voltage cable to the klystron; and (6) the functions of all the panel controls on the instrument.

(1) Turning Model 555 ON and OFF.

When the necessary details involved in the operations listed above have been properly executed, the instrument is ready to be turned on and the klystron tuned up as a source of microwave signal energy. The following steps are in the proper operating sequence. Do not deviate from them.

(a) Set all panel controls to minimum* amplitude positions. (Unless recommended otherwise, set CONTROL ELECTRODE knob at full bias position initially.)

(b) Set OVERLOAD selector switch for maximum safe beam current depending upon klystron type and operating beam voltage to be used.

(c) Turn POWER switch to ON position. The white pilot lamp on the beam-supply panel and the red pilot lamp on the upper deck should go on, indicating that input power has been applied to all tube filaments, the Control-Electrode Supply, Reflector Supply, Modulator Supply, the BLOWER receptacle, and the time-delay relay. After approximately 30 seconds (for filament warm-up) the relay will close, permitting the beam-supply input circuit to be turned on.

WARNING
HIGH VOLTAGES NOW EXIST AT THE ELECTRODES AND POWER SUPPLIES.

(d) Turn BEAM switch to ON position. The red pilot lamp on the beam-supply panel should go on, indicating that input voltage has been applied to the Beam Supply. Temporary shut-off and instant return of beam voltage without opening the time-delay circuit is accomplished with the BEAM switch.

(e) The instrument is TURNED OFF by simply throwing the BEAM and POWER switches to the OFF position, reversing steps (c) and (b) above.

(2) Adjusting the Klystron For Oscillation

(a) A sensitive r-f indicator will be required to detect the presence of the microwave signal after the proper adjustments for oscillation have been made on the tube and the power-supply voltages have been applied. A suitable crystal detector (a Type 1N21B or 1N23B is often used) and multi-range microammeter or galvanometer provide a simple and direct method for this operation. The crystal detector is ordinarily connected to the tube through 5 to 20 db of lossy coaxial cable to prevent damage to the sensitive crystal. With the medium-power, waveguide-output tubes a directional coupler and crystal detecting section can be used. It is always advantageous - and sometimes essential - to include an impedance-matching device in the transmission line coupled as close as possible to the klystron output fitting.

(b) After the Model 555 has been turned on and the components allowed to warm up for several minutes:

- - - - - - -

*CAUTION: Never throw on the POWER switch or the BEAM switch before checking that the BEAM VOLTAGE control knob has first been adjusted for a value not exceeding the maximum operating voltage to be used for the klystron beam.

1. Adjust BEAM VOLTAGE control for desired operating point within the tube specifications. Observe BEAM CURRENT meter. It should indicate that normal beam current is being drawn within the specified range of the particular klystron.

1a. If no beam current is drawn and all panel lamps are on:

(1) Apply less negative control-electrode voltage.

(2) Check for proper grounding to shell of tube.

(3) Check klystron filaments for burnout; check to see if klystron is "down to air".

1b. If no beam current is drawn and either panel lamp is out:

(1) Check all fuses on front panel.

1c. If beam current is excessive, the klystron is probably "gassy" and its useful life limited. A tube in this condition may require replacement momentarily.

2. Readjust CONTROL ELECTRODE knob to obtain desired beam current within the specified tube range.

2a. This adjustment must be made in very small increments since the effect of varying the klystron bias requires approximately 15 seconds to become evident.

3. Adjust REFLECTOR VOLTAGE control to approximately 100 volts. BEAM VOLTAGE knob has already been set to desired value.

4. Vary the REFLECTOR VOLTAGE knob slowly through the specified reflector-voltage range for the klystron until oscillation is observed. A slight dip in beam current at a certain reflector voltage setting often indicates oscillation.

5. Change the setting of the impedance-matching device in small increments if oscillation cannot be obtained, and vary the reflector voltage again as in step 4.

As the frequency of the klystron signal reaches the 10-kmc region and increases toward K-band, changing impedance characteristics of the coaxial-line fittings at these frequencies cause increasingly undesirable attenuation. It is recommended, therefore, that the Sperry Type SRU-55 and SRX-16 Klystrons, as well as the Type 2K39 (in the upper portion of its range), be mounted directly to the load rather than to a mounting panel, thus eleiminating one coaxial coupling and a length of coaxial line.

Unless this procedure is followed, it may in some cases be impossible to detect oscillation from these particular klystrons due to the excessive mismatch and resulting power losses between the generator and the load.

After oscillation has been established in tubes operating at 10-kmc and lower frequencies, it is recommended that the klystron signal be coupled to the load with a short length of JAN Type RG-5/U coaxial line. This line gives optimum r-f signal transmission to the load.

2-5b. KLYSTRON SIGNAL FREQUENCY

(1) General

Using Sperry reflex klystrons, the Model 555 Klystron Signal Source can be tuned to microwave frequencies within three closely-spaced bands covering a total frequency range of 16.75 kmc. The first (a low-frequency, medium-power band) is from 0.75 to 1.15 kmc, while the second covers the band from 1.17 kmc to 2.1 kmc at medium power. The third band gives continuous low-level coverage from 2.66 to 17.50 kmc. In addition to this, a series of three tubes (of the SRC-43 Type) furnishes medium output-power levels over the range from 6.12 to 7.43 kmc - which is also within the band covered at low level by the Type 2K44 klystron. Refer to figure 1-6 which gives the microwave-spectrum coverage obtainable with Sperry reflex klystrons.

The twelve Sperry klystrons and the 33 other types required to give the coverage specified for this instrument are all of the basic "reflex" type operating on the same principles and with roughly similar input-voltage requirements. However, because of distinct differences in r-f output fittings, resonator frequency ranges, and tuning devices, the adjustment and measurement of microwave output signals must be performed in a variety of ways using a wide range of accessory equipment. Always refer to the specific tube data sheet for detailed operating instructions, precautions, etc.

(2) Frequency Measurement

Measurements of klystron signal frequencies generally fall into the two main classifications of search and precision frequency determination.

Search techniques are employed to measure unknown frequencies within a broad band, or to adjust and set the klystron signal to frequencies where an accuracy no greater than 1 part in 1,000 will suffice. Low-Q wavemeters which permit rapid indication of resonant frequency are used for search purposes. Standing-wave detectors may also be employed in the measurement or adjustment of the approximate wavelength of a klystron signal. This method, however, gives measurements of an accuracy in order of about 2 parts in 100.

Precision measurements, on the other hand, are necessary when klystron signal frequencies accurate to 1 part in 10,000 are required. High-Q cavity meters are used for this type of precision adjustment where the approximate signal frequency has previously been determined or set with a search-meter, or known in advance within a comparatively narrow band.

In general, it is recommended that both signal oscillation and frequency be monitored simultaneously during search and precision measurements. This is advantageous for two reasons: (1) the desired setting is obtained more rapidly because stable oscillation may be maintained by constant readjustment of electrode voltages as the tube is tuned, and (2) tube life is prolonged because, if the frequency is known at all times, less "hunting" is required - thereby minimizing flexing of the klystron diaphragm.

The actual set-up used in adjusting the klystron signal to a desired frequency will depend to some extent upon the type of accessory equipment available. The block

diagrams of figures 2-3 and 2-4 suggest typical methods for performing both search and precision measurements with a variety of equipment, and with the klystron signal either modulated or unmodulated.

For rough measurement of frequency, the wavemeter may be coupled directly to the Signal Source. For more accurate measurements, this should not be done because the frequency of the klystron differs somewhat with changes in the load impedance, which is apt to vary when the wavemeter is replaced by other equipment - and will certainly change when a closely-coupled wavemeter is tuned through resonance.

Undesirable detuning effects of a changing load are reduced if atenuation is introduced between the Signal Source and the load (fig. 2-3a). Another method (fig. 2-4) is to furnish the wavemeter with only a small percentage of the output signal. This can

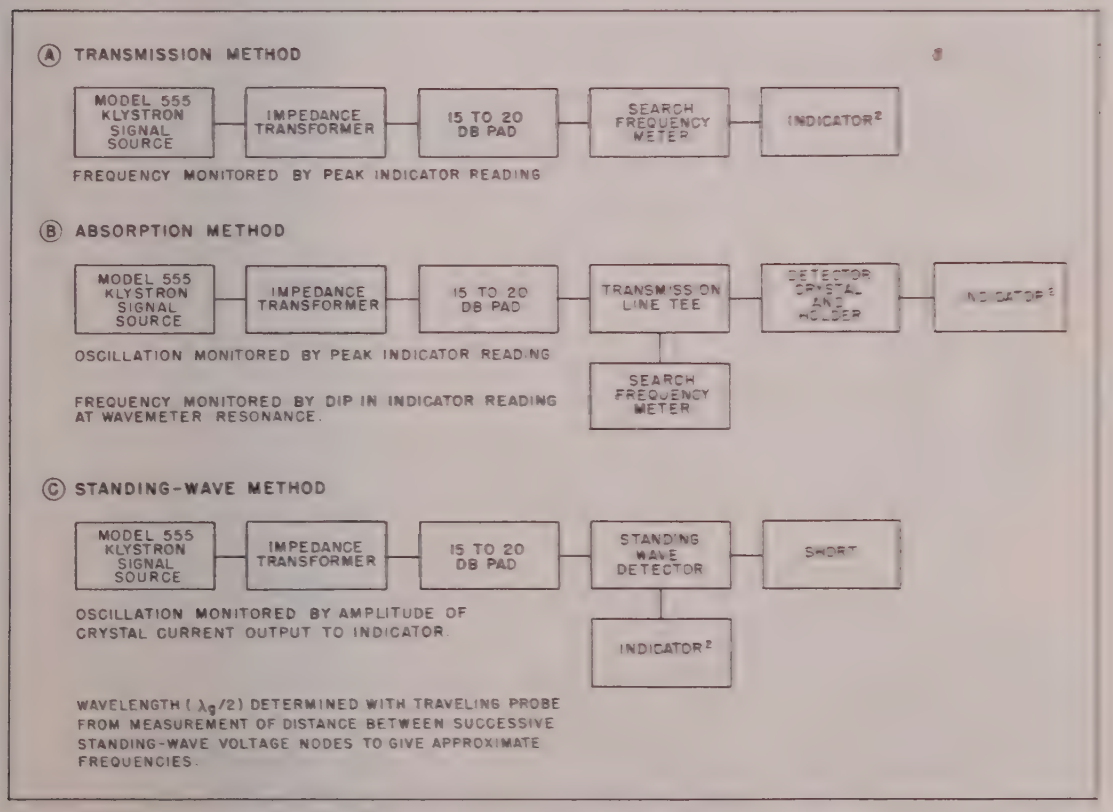
A TRANSMISSION METHOD
MODEL 555 KLYSTRON SIGNAL SOURCE
IMPEDANCE TRANSFORMER
15 TO 20 DB PAD
SEARCH FREQUENCY METER
INDICATOR[2]
FREQUENCY MONITORED BY PEAK INDICATOR READING
B ABSORPTION METHOD
MODEL 555 KLYSTRON SIGNAL SOURCE
IMPEDANCE TRANSFORMER
15 TO 20 DB PAD
TRANSMISSION LINE TEE
DETECTOR CRYSTAL AND HOLDER
INDICATOR[2]
OSCILLATION MONITORED BY PEAK INDICATOR READING
FREQUENCY MONITORED BY DIP IN INDICATOR READING AT WAVEMETER RESONANCE.
SEARCH FREQUENCY METER
C STANDING-WAVE METHOD
MODEL 555 KLYSTRON SIGNAL SOURCE
IMPEDANCE TRANSFORMER
15 TO 20 DB PAD
STANDING WAVE DETECTOR
SHORT
OSCILLATION MONITORED BY AMPLITUDE OF CRYSTAL CURRENT OUTPUT TO INDICATOR.
INDICATOR[2]
WAVELENGTH ($\lambda_g/2$) DETERMINED WITH TRAVELING PROBE FROM MEASUREMENT OF DISTANCE BETWEEN SUCCESSIVE STANDING-WAVE VOLTAGE NODES TO GIVE APPROXIMATE FREQUENCIES.

FIGURE 2-3 - SEARCH FREQUENCY MEASUREMENTS WITH MODEL 555 KLYSTRON SIGNAL SOURCE - BLOCK DIAGRAM

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[1]Refer to Sperry Microline catalog for applicable microwave components used in each frequency band.

[2]Search frequency measurements may be performed with either c-w or square wave modulated klystron signals in the measurement techniques outlined above. A microammeter may be used as an indicator for unmodulated signals, while an audio amplifier with a suitable output level meter is employed as an indicator when square wave modulation is used.

be accomplished by means of a power divider (a directional coupler may be used). Detuning (frequency-pulling) effects of the wavemeter, when at resonance, are minimized when sufficient decoupling is provided by this method.

(3) Adjustment of Klystron Signal to a Given Frequency

The considerations and operating procedure for obtaining a desired microwave output frequency are summarized herewith. As in the case of other Model 555 operating procedures, they are not to be considered as wholly inflexible rules except where cautions are given. The suggested sequence should be followed closely by a new operator until he gains experience with the techniques, after which the sequence may be adapted to the special requirements of any particular application.

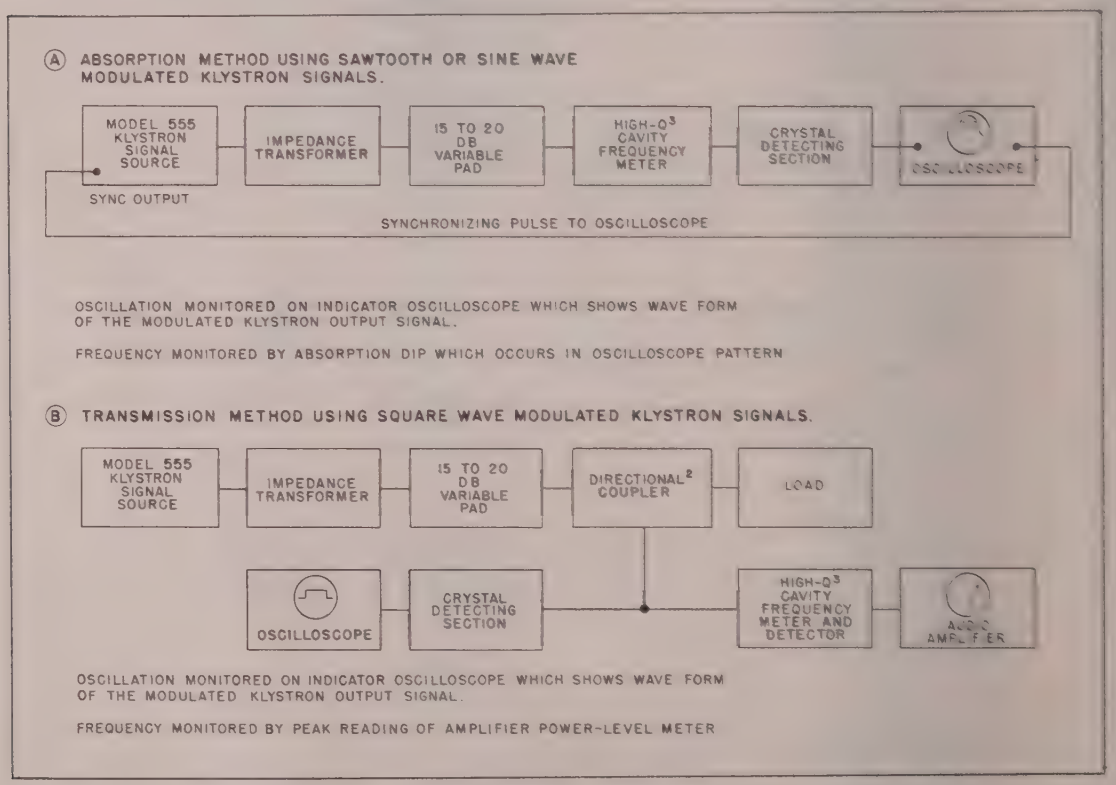
(A) ABSORPTION METHOD USING SAWTOOTH OR SINE WAVE MODULATED KLYSTRON SIGNALS.
MODEL 555 KLYSTRON SIGNAL SOURCE
IMPEDANCE TRANSFORMER
15 TO 20 DB VARIABLE PAD
HIGH-Q[3] CAVITY FREQUENCY METER
CRYSTAL DETECTING SECTION
OSCILLOSCOPE
SYNC OUTPUT
SYNCHRONIZING PULSE TO OSCILLOSCOPE
OSCILLATION MONITORED ON INDICATOR OSCILLOSCOPE WHICH SHOWS WAVE FORM OF THE MODULATED KLYSTRON OUTPUT SIGNAL.
FREQUENCY MONITORED BY ABSORPTION DIP WHICH OCCURS IN OSCILLOSCOPE PATTERN
(B) TRANSMISSION METHOD USING SQUARE WAVE MODULATED KLYSTRON SIGNALS.
MODEL 555 KLYSTRON SIGNAL SOURCE
IMPEDANCE TRANSFORMER
15 TO 20 DB VARIABLE PAD
DIRECTIONAL[2] COUPLER
LOAD
OSCILLOSCOPE
CRYSTAL DETECTING SECTION
HIGH-Q[3] CAVITY FREQUENCY METER AND DETECTOR
AUDIO AMPLIFIER
OSCILLATION MONITORED ON INDICATOR OSCILLOSCOPE WHICH SHOWS WAVE FORM OF THE MODULATED KLYSTRON OUTPUT SIGNAL.
FREQUENCY MONITORED BY PEAK READING OF AMPLIFIER POWER-LEVEL METER

FIGURE 2-4 - PRECISION FREQUENCY MEASUREMENTS WITH MODEL 555 KLYSTRON SIGNAL SOURCE - BLOCK DIAGRAM

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[1] Refer to Sperry Microline catalog for applicable microwave components used in each frequency band.

[2] Use an appropriate directional coupler for frequency measurements on medium-level and high-power klystrons with either amplitude or frequency modulation. For low signal levels, replace the directional coupler with the frequency meter, and substitute the crystal detecting section for the load.

[3] By the substitution of low-Q frequency meters, the techniques of figure 2-4 may also be used for search frequency measurements.

(a) Required Accessory Equipment

Dependent upon: (1) whether an approximate or a precision frequency value is required, (2) frequency range of klystron, (3) type of klystron r-f output terminal, and (4) klystron r-f power level. Refer to figures 2-3 and 2-4, and the Sperry Microline Instrument catalog* for suitable coaxial and waveguide microwave components.

(b) Preliminary Klystron Data Required

Note all pertinent information in applicable Sperry Klystron Data Sheet covering frequency and tuning. Depending upon the particular tube type and application, specifications on the following points must be checked: (1) minimum frequency range, (2) minimum r-f output power, (3) nominal mounting-flange separation, "A", at mid-frequency, (4) tuning variation of "A" dimension to cover full frequency range, (5) mechanical tuning range at band edges with applicable tune knob, (6) maximum electrode voltages and currents, (7) reflector mode characteristics, (8) electronic tuning coefficient and bandwidth in region of desired frequency and mode of operation.

(c) Preliminary Adjustments for Tube Alignment, Oscillation, and Starting Frequency

When operating a klystron which does not incorporate a full-range or built-in tuner, check mounting-flange separation for alignment, and measure "A" dimension. Realign or reset "A" dimension as required. After assembly to tuner and installation to a mounting fixture or the waveguide, adjust electrode voltages for stable oscillation and measure approximate frequency. Refer to figure 2-3 for approximate method.

(d) Tuning the Klystron Signal to a Given Frequency

In general, the tube can now be tuned to any given frequency within the mechanical tuning range of the tuner by simultaneous adjustments of the tuner knob and the reflector voltage - the voltage adjustment being necessary to maintain oscillation. The knob rotation is clockwise to increase, and counterclockwise to decrease frequency. As shown in figure 2-3b, both klystron signal frequency and oscillation amplitude are monitored continuously during this operation. Adjustment to any point in the specified frequency range of Sperry Klystron Types 2K41, 3K23, 3K27, and the SRU-55 tubes can be made by following this procedure since these tubes incorporate full-range tuners. However, further tuning may be required of the other types listed for the Model 555.

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*Publication No. 23-30

(e) Additional Tuning Required for Klystron Types 2K39, 2K42, 2K43, 2K44 and SRO-16

In the case of klystron types which are not equipped with a full-range tuner, the mechanical tuning range of the tuner is appreciably less than the entire frequency band which the klystron is capable of covering. For example: the Model 12 Tuner adjusts the output signal over 30 percent of the frequency range at the low end of the band, but covers only 13 percent at the high-frequency end. Note the non-linearity in the rate of frequency shift at either end of the band. This is a characteristic of all klystrons and must be taken into account when making frequency adjustments.

When the frequency difference between that originally measured, step (c), and the desired frequency exceeds the mechanical tuning range of the tuner, an additional operation must be performed. This consists of an adjustment to the three coarse tuning struts.

Keeping in mind the "A" dimension range corresponding to the specified band edges, the originally measured mounting-flange separation and the rotation per strut required to cover the tuning range, turn each strut by small (90° max) but equal increments (clockwise to increase; counterclockwise to decrease frequency) and measure the klystron signal frequency after each set of adjustments until the r-f output frequency is close to that desired. As in step (d), readjustment of the reflector voltage will be found necessary.

(f) Final Frequency Adjustments, Electronic Tuning, Precision Tuning with High-Q Meter.

Once the search-wavemeter reading has indicated that the klystron is oscillating at a frequency close to that desired, step (d) or (e), a more sensitive adjustment is made with the tuning knob. The reflector voltage which up to this point has been employed to maintain stable oscillation, can now be used to give the most sensitive vernier adjustment to the r-f output frequency (electronic tuning). However, the tube should not be fixed at a final frequency setting until electrode and impedance-matching adjustments have been completed to obtain the desired microwave power level within the tube's rated capacity at which operation is desired (see Paragraph 2-3d). At that time the search meter should be replaced by a high-Q, cavity-type frequency meter if extreme accuracy of signal frequency is required (Fig. 2-4).

PRECAUTIONS

1. Since certain coaxial wavemeters operate at a quarter-wave line length, a frequency at any odd multiple of the frequency represented by the meter setting will excite resonance. Some types are calibrated for a three-quarter-wave line length. Therefore energy at one-third or any odd multiple of the frequency

represented by the micrometer setting will also excite resonance. Where a very wide frequency range is covered by a wavemeter, the search for resonance should be started from the high-frequency end. The first resonance observed occurs when the line length is one-quarter-wave long.

2. With modulated signals it is possible to obtain responses at the sideband frequencies. Care must be taken that these resonances are not confused with those of the main signal.

3. When squarewave modulation is used, two responses may be obtained which correspond to two modes of operation of the signal source. The response at the undesired frequency can normally be eliminated by reflector-voltage adjustments to prevent the occurrence of the second mode.

2-5c. KLYSTRON SIGNAL POWER

(1) General

Output ratings for the reflex klystrons operated with the Model 555 Klystron Signal Source are specified as the nominal r-f output power (c-w) obtainable under typical operating conditions. Refer to Table I, p.9.

Operating with Sperry Klystrons the following power is available:

(a) At the low-frequency end of the band between 0.75 and 2.1 kmc, 1 watt is available.

(b) From 2.66 to 7.50 kmc, 1/4 watt can be produced by the coaxial-output tubes, while from 6.12 to 7.43 kmc, a nominal 1-watt output is provided by the Type SRC series waveguide output tubes.

(c) Between 10.3 and 15 kmc the output is adequate for low-level applications only. However, the Type SRU-55 tube gives a nominal 20 milliwatts between 14 and 17.5 kmc.

Table II, p.11, lists the Microwave output Power of the non-Sperry klystrons.

(2) Control and Adjustment of Microwave Output Power in the Reflex Klystron

Variation of klystron electrode voltages at any given resonator grid spacing changes the phase and rate at which the electron bunches in the beam arrive at the resonator, thereby causing both frequency and oscillation amplitude to fluctuate accordingly.

The Sperry Klystron Data Sheets summarize the r-f output-power characteristics of these tubes, as well as the nominal electrode voltages required for stable operation over the range of available r-f output levels. It will be seen from a study of these tables and curves that to maintain satisfactory oscillation, any change in one electrode voltage must be compensated for by a corresponding variation of another electrode potential. Operation is thus seen possible with: (1) "constant-mode" adjustment of all electrode voltages, and (2) "reflector-mode" control where only the reflector potenial is

varied through its specified range and all other electrode potentials are held constant. "Reflector-mode" operation is the more commonly used of the two methods. Output power, in general, becomes greater with an increase in input power, and with increased reflector voltage.

(3) Measurement of Model 555 Klystron Signal Power

Within the output-power range of the klystrons used with the Model 555, the most convenient way to measure actual r-f output is by means of a wattmeter bridge and associated barretter mounts. Average power levels over a 40-db range from a few microwatts to ten milliwatts can be measured directly using Sperry Microline power-measurement instruments, and this range can be extended to inputs of several hundred watts by means of suitable calibrated microwave attenuators and/or directional couplers.

When a desired klystron signal level has been obtained and output stabilized at that point, the incident microwave signal can be monitored (if necessary) with a crystal detecting section decoupled from the main transmission line by an appropriate directional coupler.

(4) Adjustment of the Tuned Klystron to a Given Power Level

(a) Refer to the applicable Klystron Data Sheet and select the reflector mode which best approximates the desired power level.

(b) If the chosen signal level exceeds the wattage capacity of the microwave power-measuring device to be used, always introduce sufficient variable calibrated attenuation between the klystron and the sensitive r-f head before applying electrode voltages to the klystron. This will prevent possible burn-out of the microwave measuring device. The voltage standing-wave ratio in the transmission line should be kept low to avoid excessive reflection of incident power.

(c) Adjust the electrode voltages to the values recommended in the applicable Klystron Data Sheet. Monitor power and frequency during this initial adjustment.

(d) If the desired power level is not obtainable by the operations performed in step (c), adjust the beam current within the specified tube ratings by varying the control-electrode voltage. A less-negative bias tends to increase beam current and output power.

(e) Since the impedance match presented to the klystron is also a controlling factor in the stability and amplitude of the output signal, it may often be necessary to make matching adjustments in order to obtain a desired output level. The impedance transformer should be located as close as possible to the klystron r-f output terminal to obtain optimum performance from the tube.

(f) Once the desired output power has been obtained, final tuning adjustments (fig. 2-4) should be performed on the klystron (if a precise

signal frequency is desired) because changes in the electrode voltages after the original tuning operation will have shifted the output frequency. Use the cooling blower at all times to maintain optimum stability.

2-5d. MODULATION OF THE KLYSTRON SIGNAL

(1) General

The Klystron Data Sheets summarize the theory, methods, and operations involved in amplitude or frequency modulation of the klystrons used with this instrument.

The Model 555 Modulator Unit provides suitable squarewave output as recommended in these sheets for keying or amplitude modulation. It also furnishes both sawtooth and sinewave voltages for sweeping or frequency-modulating all the reflex tubes operated with the Klystron Signal Source. Provision is made in the Model 555 for the application of modulating voltages to the d-c voltage of the klystron reflector electrode only. The Modulator provides a choice of squarewave and sawtooth frequencies between 600 and 1050 cps, while the sinewave modulation frequency is that of the input a-c line voltage. In all three waveshapes the amplitude is continuously variable from 0 to 300 volts peak-to-peak.

Among other uses, squarewave-modulated klystron signals find important microwave applications in the measurement of voltage standing-wave ratios, attenuation, relative power, and search frequencies. Sinewave and sawtooth modulation is often used in both search and precision microwave frequency measurements, as well as in other systems and receiver circuits. The MODULATION OUT panel receptacle and amplitude control provide a means for monitoring the modulation waveshape with an oscilloscope in order to analyze and compare this signal with the microwave-output carrier envelope.

(2) Squarewave Modulation of the Klystron Signal

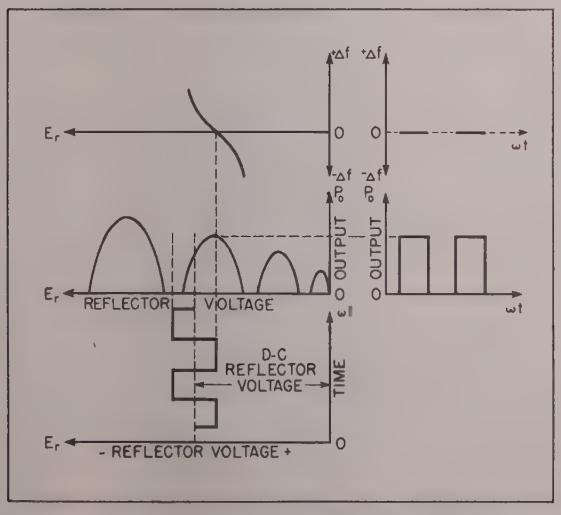


FIGURE 2-5 - REFLEX KLYSTRON AMPLITUDE MODULATION

In the application of squarewave modulation, the sum of the d-c and squarewave voltages should be such as to switch the r-f voltage on and off by swinging the reflector voltage from the peak or center of a reflector mode to a point between modes, (refer to figure 2-5). With improper d-c or modulation amplitude it is possible to switch from one level and frequency to another within a mode, or to switch from one mode to another. This adjustment can be made more satisfactorily if the squarewave characteristics are observed on an oscilloscope placed in the transmission line carrying the modulated klystron signal. The modulation amplitude should be set near the minimum necessary to obtain a good clean squarewave (fig. 2-4b).

Frequency modulation is held to a negligible minimum in the Model 555 by making the rate-of-rise and fall of the squarewave about five microseconds.

(3) Sawtooth or Sinewave Modulation of the Klystron Signal

When frequency modulating the d-c reflector voltage with a sawtooth or sinewave signal, the frequency excursion is determined by the amplitude of the applied voltage. The most linear frequency modulation is obtained when the d-c portion of the reflector voltage is set at the center of the mode and the applied signal does not extend beyond the linear portion of the reflector tuning curve (refer to figure 2-6). In the Model 555 the sawtooth decay time of less than 15 microseconds provides satisfactory modulation for sweep-frequency applications. Amplitude modulation is minimized by limiting the modulating voltage to a small section of the mode, and by not permitting it to extend beyond the mode. If possible, select a reflector mode with a characteristic giving a large frequency deviation per volt.

(4) Locking the Modulation Frequency With the Synchronizing Circuit

It is often desired to lock the modulating frequency at some chosen value within the frequency range of the Modulator. This may be accomplished by the introduction of an external synchronizing voltage of crom frequency through the BNC panel SYNC. connector (J-2[illegible]). The Modulator toggle switch should be kept on the INT. position during this operation. In this operation the FREQUENCY panel control should be adjusted to approximate the frequency of the external synchronizing voltage.

(5) Synchronizing an External Device with Pulses from the SYNC. Receptacle.

This synchronizing arrangement can play an important part during the adjustments required for satisfactory frequency modulation of the klystron signal. In this application the Modulator supplies synchronizing pulses from the SYNC. connector (J-2[illegible]) to an oscilloscope to lock the oscilloscope sweep at the modulation frequency (Fig. 2-4a). As in the squarewave modulation procedure already described, the modulated klystron signal is detected by a crystal whose output is fed to the oscilloscope to indicate the waveform of the modulated klystron output. The modulation can now be altered by amplitude or frequency adjustments and its effect on the klystron signal monitored until the desired characteristics have been obtained. For comparison purposes, the modulation signal being applied to the reflector can be coupled from the MODULATION OUT panel receptacle (toggle switch on EXT. position) and introduced into an oscilloscope.

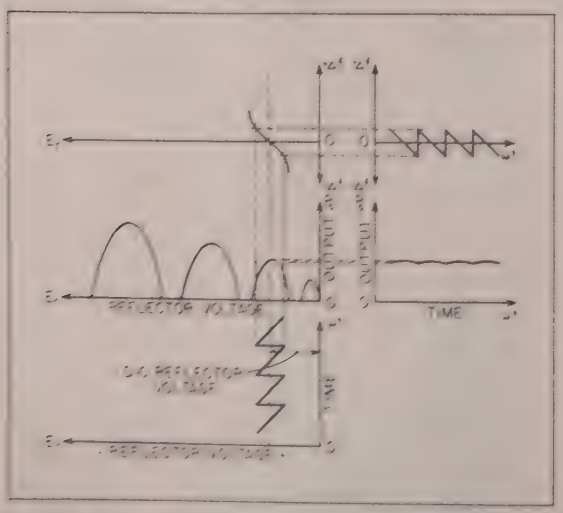


FIGURE 2-6 - REFLEX KLYSTRON FREQUENCY MODULATION

(6) External Modulation of the Klystron Signal

External modulation may be required for some applications. First, narrow

the Modulator toggle switch to EXT. position, and then couple the output cable from the external modulating device to the MOD. IN connector (J-202). Adjust the external modulation amplitude for the minimum necessary to obtain proper r-f output waveform.

A clipper tube (V-205) in the Reflector Supply prevents the reflector electrode from developing a positive potential over any part of an internally or externally applied modulation cycle. Without this protection the klystron reflector circuit would draw current over the positive portion of the cycle which could result in damage to the klystron.

The characteristics of capacitor C-206, which couples both external and internal modulation to the reflector electrode, are such that much lower modulating frequencies than heretofore used can be applied to the klystron reflector. In addition, the capacitance to ground of the internal wiring of the reflector lead is unusually low. In applications where very short pulses are used, the external reflector lead should be isolated.

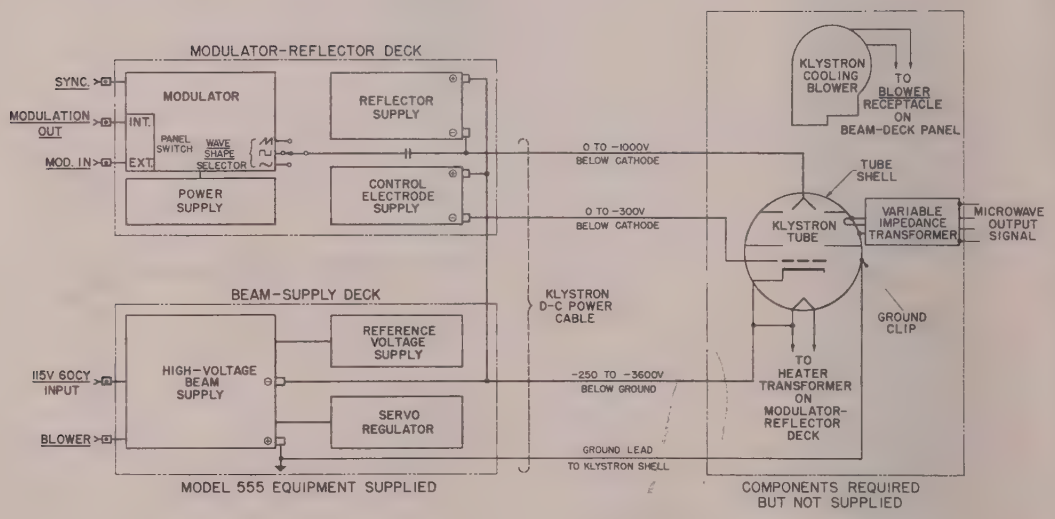


FIGURE 3-1 - MODEL 555 KLYSTRON SIGNAL SOURCE - BLOCK DIAGRAM

SECTION III

THEORY OF OPERATION

3-1. GENERAL

The electrical functions of the various units comprising the Model 555 are covered in this section of the manual. The units are discussed under three classifications: (1) beam-deck circuits, (2) modulator-reflector deck circuits, and (3) the reflex klystron oscillator.

A simplified block diagram of the Signal Source is given in figure 3-1 which shows the major components and their interconnections. The figure also includes items of equipment commonly required but not supplied with Model 555. The klystron signals are generated by a velocity-modulation tube of the reflex type whose reflector electrode can be amplitude or frequency modulated to provide pulsed or swept microwave signals to an external load. The beam-supply deck of the Model 555 furnishes an extremely wide range of negative d-c voltage for the klystron cathode. The positive side of this supply is grounded to the shell of the klystron. The Beam Supply operates in conjunction with a separate Reference-Voltage Supply and a Servo-Regulator Unit to provide a smooth, continuously-adjustable output voltage which remains constant at any desired setting regardless of variations in line voltage and load current. An overload selector switch is provided to protect both the klystron and the power supply from the effects of excessive beam currents.

The modulator-reflector deck includes the Modulator and its separate power supply, as well as the sources of reflector, heater and control-electrode voltages for the klystron. The block diagram (fig. 3-1) indicates how the positive side of both the reflector and control-electrode outputs are tied to the negative side of the Beam Supply so that the voltages applied to the reflector and control electrode are negative with respect to the klystron cathode. One side of the heater is also made common with the cathode at the klystron socket.

3-2. BEAM-DECK CIRCUITS

3-2a. BEAM SUPPLY

The electrical schematic for the beam-deck circuits is given in figure 3-2*. The principles of operation of these circuits can be more easily understood if reference is made to this figure while reading the applicable text which follows.

- - - - - - -

* Figure 3-2, a foldout, is located at the end of the text on pages 67-68.

When the POWER switch (S-101) is thrown on, the primary a-c input voltage connected at 115 V 60 CY (J-102), the recessed panel connector, flows through fuse F-101 and to plug P-201 on the modulator-reflector deck by way of the chassis-interconnecting cable. Here the current passes through interlock switch S-201 (assuming the rear door of the cabinet to be closed) and all circuits on the upper deck are thereby energized. Output voltage is therefore available from the klystron Reflector, Control-Electrode and Heater Supplies as well as from the Modulator. At the same time panel lamps I-101 and I-201 on the lower and upper decks are illuminated, 115V a-c is available at the panel BLOWER receptacle, the heater of time-delay relay K-105 starts to warm up, all other tube filaments in the beam deck are activated except those in the circuit of the Servo-Regulator Unit, and the -150V d-c Reference Supply is energized.

The initial presence of the 115V primary input also causes motor B-101 to rotate ccw, thereby placing variable control terminal 3, on Powerstat T-102 to zero voltage position (at terminal 4). This automatic action, resulting in zero input to the Beam Supply, occurs because of the unenergized contact positions on relays K-101 and K-102 located in the circuits of the cw (raise) and ccw (lower) motor shading coils. When T-102 has reached its minimum output position, the motor stops and simultaneously closes S-103 located between pin 7 of K-105 and terminal 2 of K-103.

After a delay of 30 seconds K-105 closes, thereby energizing K-104 which in turn makes a circuit between contact 7 and contact 6. A-c voltage is then available at the input to the BEAM panel switch, and K-105 is de-energized.

When the BEAM switch (S-102A and S-102B) is thrown on, red panel lamp I-102 is illuminated, voltage is supplied to T-101 energizing the entire circuit of the Servo-Amplifier Unit, and the output of the d-c Reference-Voltage Supply is furnished to the beam circuit through S-102B.

As soon as the servo-regulator circuit is operating, motor B-101 automatically adjusts the setting of T-102 to the beam-voltage value indicated by the position of the BEAM VOLTAGE panel control. In operation it is important to switch the OVERLOAD selector to the most suitable setting, which is dependent upon the individual klystron beam voltage and current characteristics.

The selective overload-relay circuit is provided to protect the klystron from excessive beam current. The relay is located in the line between filter output choke L-103 and the plates of gate tubes V-111 and V-112. The selector switch can be set so that the circuit will be broken in the a-c input line when the beam current exceeds any one of four values. If this happens, the thermal time-delay relay must go through its cycle before the primary input voltage is available again.

The regulating action of the Beam Supply takes the following form:

Changes in the voltages across the divider made up of resistors R-133, R-135, R-136, R-137 and R-138 are picked off between R-133 and R-135 and impressed upon the grid of V-113. The difference between the steady-state, grid-to-cathode potential and that due to a voltage change is then amplified and appears on the grid of V-113. The difference signal is again amplified and applied to the grids of gate tubes V-111 and V-112 in such a way as to keep the output voltage constant.

3-2b. SERVO-REGULATOR UNIT

In obtaining d-c beam potentials over the range from -250 to -3600 volts, the circuit functions as follows:

The BEAM VOLTAGE panel control adjusts the settings of ganged potentiometers R-135, R-136 and R-137 located across the output of the Beam Supply. If a higher output voltage is desired, the control is turned clockwise. This increases the output voltage and lowers the voltage across gate tubes V-111 and V-112. The potential across the gate tubes must be maintained at approximately 200 volts at all times. Thus when there is a tendency for it to fall below this value, the change also appears across resistors R-106, R-107, R-108, R-109 and R-110 which are connected in series and shunted across the plate and cathode of the gate tubes. The series of resistors is connected to several points in the circuit of the Servo-Regulator so that proper relays may be energized, shorting the "raise" shading coil of the motor and starting the motor, which in turn rotates the Powerstat to provide the additional secondary voltage at T-103 required to restore the voltage drop to normal across the gate tubes and provide the desired additional d-c beam voltage at pins H and D of J-104.

In order to lower the d-c output voltage to the klystron cathode, the BEAM VOLTAGE control is adjusted in the counterclockwise direction causing the opposite effect from that described in the "raise" sequence.

For ease of comparison the three operating states of the Servo Regulator are tabulated below:

STATE I - Decreasing the Beam Voltage

The BEAM VOLTAGE control is turned ccw causing more negative bias which results in an increased voltage drop across the gate tubes. Therefore, neither side of V-104 conducts causing the motor to lower the voltage. In this state:

1. "LOWER" relay is UNENERGIZED.
2. "LOWER" shading coil is SHORTED.
3. "RAISE" relay is UNENERGIZED.
4. "RAISE" shading coil is OPEN.

STATE II - Increasing the Beam Voltage

The BEAM VOLTAGE control is turned cw causing a more positive bias which results in a lower voltage drop across the gate tubes. Therefore, both sides of V-104 conduct causing the motor to raise the voltage. In this state:

1. "LOWER" relay is ENERGIZED.
2. "LOWER" shading coil is OPEN.
3. "RAISE" relay is ENERGIZED
4. "RAISE" shading coil is SHORTED.

STATE III - Steady-State or Constant Output

The BEAM VOLTAGE control remains untouched. The "lower" section of V-104 conducts, since the bias at pin 7 is more positive because it is tied to a point higher up on the divider, causing the motor to hold steady. In this state:

1. "LOWER" relay is ENERGIZED.
2. "LOWER" shading coil is OPEN.
3. "RAISE" relay is UNENERGIZED.
4. "RAISE" shading coil is OPEN.

In order to function smoothly and without "hunting", the servo-regulator circuit controlling the rotation of the motor has been designed with "anticipation-response". This means that when operating under either the "lower" or "raise" conditions, the new value of output voltage is obtained without "overshooting" or "undershooting", because the circuit is so devised that the servo bias-control signal is intentionally set to be slightly false. Therefore, the final voltage is achieved in progressively smaller steps as the grid bias on V-104 is automatically cycled to give the proper amount of relay response near the desired output-voltage point at which the Servo Regulator reassumes the steady-state condition.

3-2c. REFERENCE-VOLTAGE SUPPLY

This supply provides a very stable negative d-c reference potential of -175 volts to the cathode (pin 8) of V-107B in the Beam Supply (fig. 3-2). This constant reference voltage is required to provide optimum stability of the output voltage for the klystron cathode, since any variations in the reference voltage are automatically reflected in the output of the Beam Supply. The output of the Reference Supply is electronically regulated by a circuit basically similar in operation to that of the Reflector Supply (see paragraph 3-3).

In order to prevent the application of the reference voltage to the cathode of V-107B when the Beam Supply is not being operated, the BEAM switch (S-102B) and relay K-104 are tied into the -175V line so that when the BEAM switch is off, no reference voltage can be introduced into the Beam Supply.

3-3. MODULATOR-REFLECTOR DECK CIRCUITS

When the POWER switch (S-101) on the beam deck is thrown on, a-c input power is available at P-201 on the modulator-reflector deck by way of the interconnecting cable. If fuse F-201 is intact, red panel lamp I-201 glows and the primaries of T-201 and T-202 are energized, thereby providing the required input voltages for the Modulator, the Heater, Reflector and Control-Electrode Supplies.

3-3a. MODULATOR

The Model 555 Modulator incorporates a uniquely compact design in which almost every tube possesses several functions depending upon the positioning of the WAVE SHAPE selector switch on the panel. Modulator output voltages of three types are provided: sawtooth and sinewave for frequency modulation, and squarewave voltages for amplitude

modulation of the klystron reflector electrode. All three signals can be varied in amplitude from 0 to 300 volts peak-to-peak. The frequency of the sawtooth and squarewave voltages can be adjusted over the range from 600 to 1050 cps. Reference should be made to the schematic diagram of figure 3-3* while studying the theory of operation of the Modulator.

(1) Analyzing the Modulation Signal

Because modulation troubles can often be analyzed more easily at the source of the modulation signal, MODULATION OUT jack J-203 (fig. 3-3) is provided on the front panel of the modulator-reflector deck. The voltage available at J-203 (representing a small portion of the Modulator output signal) is coupled from the plate of V-212 through capacitor C-224 and is then applied to the grids of V-214 through potentiometer R-259. The MODULATION OUT panel control is attached to the shaft of R-259 to permit adjustment to the amplitude of the signal appearing at J-203. This control operates entirely independently of the AMPLITUDE panel control which is used to adjust the magnitude of the modulation signal impressed on the klystron reflector electrode. V-214 acts as a cathode follower in the circuit and the modulation signal impressed upon its grids is removed from the cathodes of this tube directly to J-203 from which the modulation waveshape can be conveniently viewed with an oscilloscope. MOD. IN panel jack J-202 provides an input point for modulating the klystron reflector with signals from a source external to the Model 555.

(2) Sawtooth Function

The modulator circuit can most readily be understood by a separate review of each of the three functions, starting with that for sawtooth operation.

In the Modulator sawtooth function a fixed potential is applied through resistors R-233 and R-232 to pin 2 of the first half of V-210 (with the WAVE SHAPE control set to providing approximately 100 volts to the grid of this tube which acts as a cathode follower supplying a fixed voltage to the screen of V-212.

The second section of V-210 acts as a blocking oscillator whose frequency is controlled through adjustable grid resistor R-238 and charging capacitors C-215 and C-216 in series as connected through pins 3 and 4 of S-202A. The sawtooth output of the blocking oscillator is fed from the junction of capacitors C-216 and C-215 (which operate as a capacitive voltage divider) through pins 7 and 8 of S-202A to amplitude-control potentiometer R-252 whose counterclockwise terminal is connected to ground through pins 3 and 4 of S-202B.

The variable sawtooth output, as available through the slider of R-252, is applied through pins 11 and 12 of S-202B through parasitic-suppressor resistor R-254 to the grid of V-212 which operates as a Class-A amplifier to the sawtooth signal. Using plate resistor R-253 and peaking choke L-203 the output of V-212 is applied directly to the Modulator output point (C-206) through pins 1 and 2 of S-203. In the sawtooth function clipper tube V-213 is disabled since pin 8 of S-202B has no connection in this position of the selector switch.

- - - - - - -

* Figure 3-3, a foldout, is located at the end of the text on page 69-70.

(3) Squarewave Function

In the Modulator squarewave function the WAVE SHAPE control is set to ⊓. An adjustable voltage is thereby applied to the grid of the first section of V-210, a cathode follower, whose input voltage is applied through amplitude control R-252 under the following conditions:

The clockwise terminal of R-252 is fed through R-251 to B+ through pins 7 and 9 of S-202A. The counterclockwise terminal of R-252 is fed through the negative bus (-105V) through resistor R-250, and through pins 3 and 5 of S-202B. This provides a d-c voltage on the slider of R-252 which varies from a small negative value to approximately +150 volts. The variable voltage on the slider of R-252 is then applied through terminals 1 and 11 of switch S-202A to the grid of the first section of V-210. This adjustable voltage then appears on the cathode of the first section of V-210 and is applied as a variable voltage to the screen of V-212.

The second section of V-210 is a cathode-plate-coupled blocking oscillator comprising the plate-winding (terminals 3 and 4) of blocking-oscillator transformer T-203 - terminal 4 being returned to B+ through decoupling resistor R-235 and through decoupling capacitor C-213 to ground. The cathode winding of blocking-oscillator transformer T-203 is grounded through terminal 2 and feeds the cathode of the blocking oscillator through terminal 1. In addition, coupling is made through capacitor C-211 to jack J-201 which supplies an output trigger. J-201 can also be used in conjunction with an external trigger for synchronization of the blocking oscillator. Frequency control of the blocking oscillator is achieved through modulation FREQUENCY control potentiometer R-238 and capacitor C-217 in series with resistor R-237 which limits the upper range of frequencies as an extension of R-238. The frequency range provided by these components is exactly twice the frequency range of the blocking oscillator in the sawtooth function. R-237 is fed from B+ through decoupling resistor R-236 and by-passed to ground through decoupling capacitor C-214A.

In the squarewave function, output from the blocking oscillator tube (V-210) consists of negative pulses shaped by the decoupling networks C-213 and R-235. These negative pulses are applied through C-218 to the junction of resistors R-241, R-242 and R-243 which represent the plate-load resistors of the Eccles-Jordan tube (V-211). The triggers so applied to the plates of V-211 are transmitted simultaneously through the plate resistors R-241 and R-243 and then through capacitors C-219 and C-220 to the opposite grids of the Eccles-Jordan tube, thereby causing alternate conduction of the triode sections. This provides a squarewave whose frequency is one half the frequency of the blocking oscillator, and therefore corresponds to the same range of frequencies as provided in the sawtooth function.

The Eccles-Jordan (or scale-of-two counter) comprises a symmetrical circuit with two triodes in which the grids of each are connected through a resistor to a source of negative bias potential. In addition each grid is coupled through a resistor by-passed by a capacitor to the plate of the opposite triode. The individual plate-load resistors are coupled to a common plate resistor. The junction of the three resistors is suitable for the application of a negative trigger voltage. The circuit design is such that, when

triggered, an inverting or changeover action is secured in which the section which had been conducting becomes non-conducting and vice-versa. A frequency division is accomplished by virtue of the fact that two successive triggers are required to return the Eccles-Jordan circuit to its initial state - one trigger forming the positive excursion of the output plate, the other trigger coinciding with the negative excursion. Thus the output frequency of the Eccles-Jordan becomes exactly one half of the input trigger frequency.

The output from the plate (pin 6) of the second section of V-211 is a squarewave which is applied through resistor R-249 and capacitor C-221 (which form a peaking circuit) to pins 1 and 11 of S-202B, on through parasitic-suppressor resistor R-254 to the grid of V-212 which is (in this circuit) no longer a Class-A amplifier, but now becomes a limiting amplifier whose output amplitude is controlled by the previously described variable screen voltage which is supplied from the first section of V-210. The variable squarewave output appearing on the plate of V-212 is applied in the square function to the clipper tube (V-213) by way of pins 7 and 9 of switch S-202B.

Tube V-213 constitutes a dual-clipper circuit which is termed a "sliding clipper" because of the fact that the reference voltages for the clipper are generated within the circuit itself and adjust themselves to the amplitude of the input signal automatically. This is achieved as follows:

During the square function an input squarewave signal is applied simultaneously to the first cathode (pin 5) and the second plate (pin 7) of V-213. The first plate (pin 2) of V-213 is by-passed to ground through capacitor C-222 and returned to B+ through resistor R-257. The second cathode (pin 1) is by-passed to ground through capacitor C-223 and returned to ground through resistor R-260 in parallel with C-223. The potentials applied to pins 1 and 2 of V-213 are such as to cause a current to flow through resistor R-260 to the second plate (pin 7) which is connected to the first cathode (pin 5), then to the first plate (pin 2), and through resistor R-257 to B+ - thus maintaining a conductive current limited chiefly by the series value of resistors R-257 and R-260. Upon the application of a squarewave signal to pins 5 and 7 of V-213, however, V-213 behaves as a doubler rectifier charging capacitors C-223 and C-222 to potentials which are directly proportional to the amplitude of the input signal. The voltage charges on C-223 and C-222 then become the reference voltages to which the input signal is clipped, providing a low impedance for the clipping of extraneous excursions such as overshoots or ripple which might otherwise appear at the output terminal. Any increase in the amplitude of the output signal will simultaneously increase the voltages on C-223 and C-222 proportionally, thus opening the clipper tube to accept a wider voltage excursion. Correspondingly, any increase in the amplitude of the input signal will cause capacitors C-222 and C-223 to discharge through resistors R-227 and R-260 respectively, decreasing the voltages applied to the clipping plate (pin 2) and cathode (pin 1) of V-213 and thereby decreasing the maximum excursions which the clipper permits at the output terminal. By being placed in parallel with the output, clipper tube V-213 is applied in such a manner as to clip both upper and lower excursions of the squarewave. The squarewave output is applied to capacitor C-206 through switch S-203.

(4) Sinewave Function

In the Modulator sinewave function the WAVE SHAPE selector is switched to ∿ which applies a fixed potential to the grid of the first section of V-210 in exactly the

same manner as for the sawtooth function refer to paragraph (2). A fixed potential of approximately 100 volts is then available at the cathode of the first section of V-210 for application as a fixed screen potential to V-212.

The second section of V-210, the blocking oscillator, is disabled through the application of a negative potential to its grid through pins 3 and 6 of S-202A. The Eccles-Jordan circuit with V-211 also fails to operate due to the absence of any trigger arriving from V-210.

In the sine function a sinewave is applied from terminal 6 of the 6.3-volt filament line through resistor-dividers R-247 and R-246. The signal then passes through pins 7 and 10 of switch S-202A to the clockwise terminal of AMPLITUDE control R-252 whose counterclockwise terminal is grounded through pins 3 and 6 of switch S-202B. The variable 60-cycle voltage is therefore available at the slider of R-252 and is applied to pins 2 and 11 of switch S-202B through parasitic-suppressor resistor R-254 to the grid of V-212 which is operating as a Class-A amplifier.

V-213, the clipper tube, is disabled in this function because of open terminal 10 on switch S-202B. The output of V-212 is therefore applied directly through switch S-203 to coupling capacitor C-206.

3-3b. REFLECTOR SUPPLY

The Reflector Supply is an electronically regulated source of d-c voltage with a continuously variable output range from 0 to -1000V below cathode (refer to the schematic diagram of figure 3-3).

D-c voltage is supplied by the full-wave rectifier, V-201 (a Type 5R4GY tube). The plate voltage for this tube is derived at terminals 3 and 5 of the high-voltage secondary windings of transformer T-201. The center tap (terminal 4) of this winding is connected to the negative d-c output terminal of the power supply. This transformer and the entire Reflector Supply are insulated for 5000 volts below ground.

The positive terminal of the supply connects to the cathode of the klystron. V-201 obtains filament voltage from terminals 6 and 7 of transformer T-201. The rectified positive voltage is taken from the cathode of V-201 through a single-section, capacitor-input filter consisting of a 350-henry choke and two 0.5-microfarad capacitors (parts L-201, C-201 and C-202). This voltage is approximately -1100 volts.

The output voltage is regulated by gate tube V-202 (a Type 12AU7) in conjunction with a regulator-control tube, V-203 (Type 12AX7). This circuit functions in the following manner:

The plates of the gate tube are connected to the -1100 volts unregulated, and the -1000 volts regulated is taken off the cathodes. Regulation of the -1000 volts is determined by the voltage drop between plates and cathodes of the 12AU7 gate tube. In turn, this voltage drop is determined by the bias on the 12AU7. The regulator-control tube (V-203) regulates the bias supplied to V-202.

V-204 is a Type 5651 cold-cathode reference tube connected between the common voltage level (klystron cathode potential) and the first cathode (pin 8) of double-triode

V-203. The constant voltage drop of 86 volts across V-204 maintains the cathode voltage of V-203 at a constant level.

Because the reference tube holds the amplifier cathode voltage at a constant level, any fluctuation in the grid voltage of V-203 caused by filter output or load variations will change the cathode-to-grid voltage at the voltage-control tube which operates as a d-c amplifier. The grid-voltage variations, which represent power-supply voltage variations, are amplified by both sections of V-203 whose output is applied to the control grids of the 12AU7 gate tube. The amplifier and gate tube are so connected that the change in the 12AU7 grid voltage adjusts the voltage drop across the tube to compensate for filter output and load variations and holds the regulator output voltage constant. At the output end of the Power Supply a by-pass capacitor (C-203) is shunted across the Type 5651 reference tube and another (C-205) is shunted across the voltage divider to further minimize ripple voltage and stabilize the output. R-214 is adjusted so that the voltage across C-205 is exactly -1000 volts.

In order to adjust the reflector voltage on the klystron to the desired value, the REFLECTOR VOLTAGE panel control is used to rotate the shaft of potentiometer R-217. Zero to -1000 volts is available. The negative output voltage from the potentiometer passes through series resistor R-220 in the circuit of V-205. At this point the reflector lead is coupled to the modulation coupling capacitor (C-206) and is then conducted to the beam deck by means of a long probe which makes contact at E-201 on the underside of the modulator-reflector deck. On the beam deck, in order to minimize capacitance to ground, the reflector voltage is "trolley-wired" to J-104, the klystron cable receptacle on the front panel.

Clipper tube V-205 (Type 6X4) is located at the output of the Reflector Supply in order to remove any positive pulses which might appear in the input to the reflector electrode. This protects the klystron from damage which might be caused if the reflector electrode become positive with respect to the shell and drew current.

The electrical characteristics of C-206, the modulation coupling capacitor, permit very low modulation frequencies to be impressed upon the reflector electrode.

3-3c. CONTROL-ELECTRODE SUPPLY

The Control-Electrode Supply is an electronically regulated source of d-c voltage which is continuously adjustable over the range from 0 to -300 volts with respect to the klystron cathode potential.

This negative voltage is obtained at the output of the same circuit which serves as the source of -1000V for the reflector electrode (see fig. 3-3 and paragraph 3-2b(1). The control-electrode voltage is taken from the slider of potentiometer R-218 which is adjusted by means of the CONTROL ELECTRODE panel control. The voltage then passes to J-104 in the beam-deck panel by way of the interconnection cable.

3-3d. HEATER SUPPLY

The klystron filament electrodes are furnished with 6.3V a-c from terminals 10 and 11 of transformer T-201 which also furnishes the input voltages to the Reflector

Supply (Fig. 3-3). The heater voltage reaches pins J and L of J-104 on the beam-deck panel by way of the interconnection cable between the upper and lower decks. The Heater Supply is electrically connected to the Beam Supply through a connection to the klystron cathode via the klystron socket.

3-4. REFLEX KLYSTRON OSCILLATOR

The microwave oscillators recommended for use with the Model 555 are of the reflex-klystron type. Although there are physical differences among many of the 45 models listed, electrically they are all basically similar - operating according to the principle of velocity modulation in order to produce output signals in the microwave frequency spectrum.

The reflex klystron (figure 3-4) consists of an electron gun which produces a focused electron beam of uniform velocity, an integral or separable reentrant cavity resonator tunable through the range of operating frequencies, and a reflector electrode which decelerates and returns the electron beam towards the resonator. The electrons are emitted from the cathode and are accelerated by the positive potentials on the grid and the resonator. Assuming a varying voltage on the resonator, those electrons that arrive when it is positive will be speeded up and those that arrive when it is negative will be slowed down. This phenomena - known as velocity modulation - results in a "bunching" of the electrons into speed groups as they proceed down the tube. Arriving near the reflector, which is maintained at a potential negative with respect to the cathode, they are repelled. If this voltage is correctly adjusted, they will be reflected back to the resonator - when the voltage on it is such that the electron bunches are slowed down - and so deliver energy to the resonator. In many klystrons the microwave energy is taken from the resonator by a coaxial probe which is terminated in the reentrant cavity by a loop.

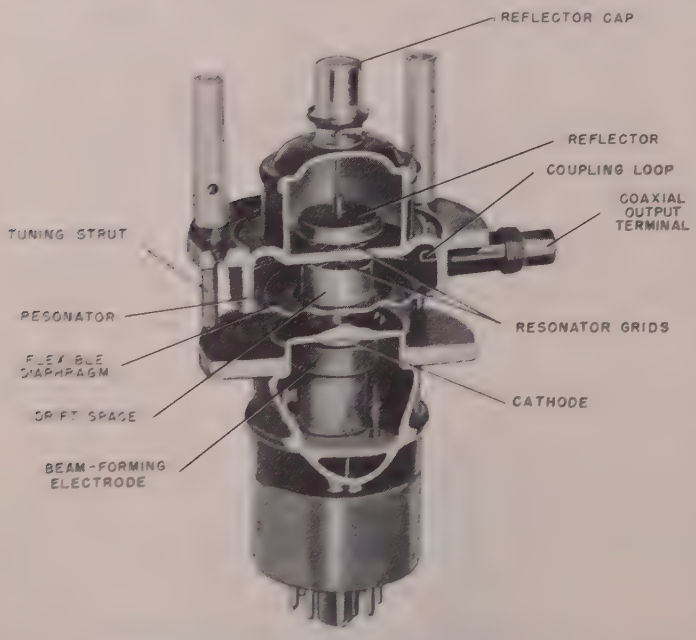


FIGURE 3-4 - REFLEX KLYSTRON - CUTAWAY VIEW

In other types a section of rectangular waveguide and sealed window in the resonator wall is employed to extract microwave power.

There are two methods for tuning a reflex klystron tube. In the first of these the tube is tuned mechanically by varying the volume of the resonator cavity and the spacing of the resonator grids. Decreasing the distance between the grids increases the capacitance of the resonant cavity, thereby decreasing the natural frequency of oscillation. This mechanical tuning is accomplished in a variety of ways.

The second method of tuning the oscillator is by

varying the reflector voltage. Only at certain values of reflector voltage will the transit time of the electrons be correct to enable oscillation at the natural resonant frequency of the resonator cavity. If the reflector voltage is varied slightly, the rate at which electron bunches will arrive at the resonator cavity will change. The tube will not stop oscillating immediately, but will shift slightly in frequency to compensate for the change in transit time. Varying the reflector voltage thus causes the frequency of the oscillator to be swept over a characteristic range which varies with the specific model.

As the reflector voltage is varied, the tube will oscillate in different modes. Typical reflex-klystron performance curves indicate that the power output of the tube is greater in the modes with the more negative reflector voltages, while range of frequency sweep within each mode decreases with increasingly negative reflector voltages.

Paragraph 2-5d describes the manner in which the klystron reflector electrode can be amplitude or frequency modulated to produce a pulsed or swept microwave output signal.

SECTION IV

MAINTENANCE

4-1. PREVENTIVE MAINTENANCE

The Model 555 Klystron Signal Source is a precision instrument designed for minimum servicing. If it is operated with a reasonable amount of care, it will give continuous optimum performance, and maintenance or repairs will be minimized.

General preventive maintenance should always include attention to three important factors.

(1) Proper Ventilation

Overheating for protracted periods of time can cause impaired performance or even premature failure of certain components in an instrument of this type. It is, therefore, important that the Model 555 be operated at as low a temperature as possible. In order to assure constant removal of the heat generated within the unit, the cabinet has been provided with a grilled cover. Side louvers and a large opening at the base of the rear door allow cool air to flow into the cabinet. The required ventilation obtained from this convection current can be cut off if other equipment is placed too close to the Model 555. It is, therefore, recommended that nothing be placed on top of the cabinet, and that, in addition, a minimum of six-inches clearance be provided at the sides and rear of the cabinet.

CAUTION
Do not obstruct Model 555 air vents at any time.

(2) Overloading

In order to prevent damage to a klystron or to the Model 555 Beam Supply during operation, it is always necessary to use the appropriate setting for the overload range-selector switch. By using the proper switch position excessive current can be avoided in the klystron and in the Beam Supply.

(3) Meter Calibration

Caution should be exercised at all times to keep the instrument out of strong, stray magnetic fields which could impair the calibration of the two panel meters.

Replacement of tubes and components can be made without restriction in all circuits. All replacement parts are commercially available items except where indicated

by accompanying Sperry part numbers in Section V, the List of Replaceable Parts.

Schematic diagrams of the two decks constituting the Model 555 Signal Source are shown in figures 3-2 and 3-3. The schematics include the circuits of the Beam and Reference Supplies and that of the Servo-Regulator, as well as those of the Modulator, and the Reflector and Control-Electrode Supplies. The function of each tube is indicated, and reference symbols and values are given for all basic circuit components. For rapid identification each panel control is shown in a box. For maintenance purposes Section V (page 57) lists all replaceable parts with their corresponding symbols and descriptions.

4-2. REMOVAL AND REPLACEMENT OF DECKS IN CABINET

The beam-supply deck and the modulator-reflector deck are separately attached to the cabinet by four mounting screws located on the front panel of each deck. Removal of the decks is accomplished by detaching these mounting screws, and disconnecting the interconnecting cable in the rear between the chassis. A pair of handles is provided on the

FIGURE 4-1 - MODEL 555 CABINET SHOWING MODULATOR-REFLECTOR DECK REMOVED

sides of each panel to aid in assembling or disassembling the units from the cabinet. Figure 4-1 is a view of the cabinet with the upper deck removed showing the supporting guides for the modulator-reflector chassis.

4-3. VOLTAGE ADJUSTMENTS

> WARNING
>
> HIGH VOLTAGES exist in this equipment. In the performance of any maintenance adjustment or test, operating personnel must observe all safety precautions to prevent loss of life.
>
> DANGEROUS POTENTIALS AFTER POWER SHUTDOWN may exist in the equipment due to charges retained by capacitors, possible breakdown of components, etc. To avoid casualties, always discharge and ground all circuits before touching them.

4-3a. BEAM

Under certain conditions it may occasionally be difficult to obtain the extreme at one or the other end of the beam-voltage range. It will then be necessary to re-set the -175V ADJ, reference-voltage potentiometer R-121 (see figure 4-2).

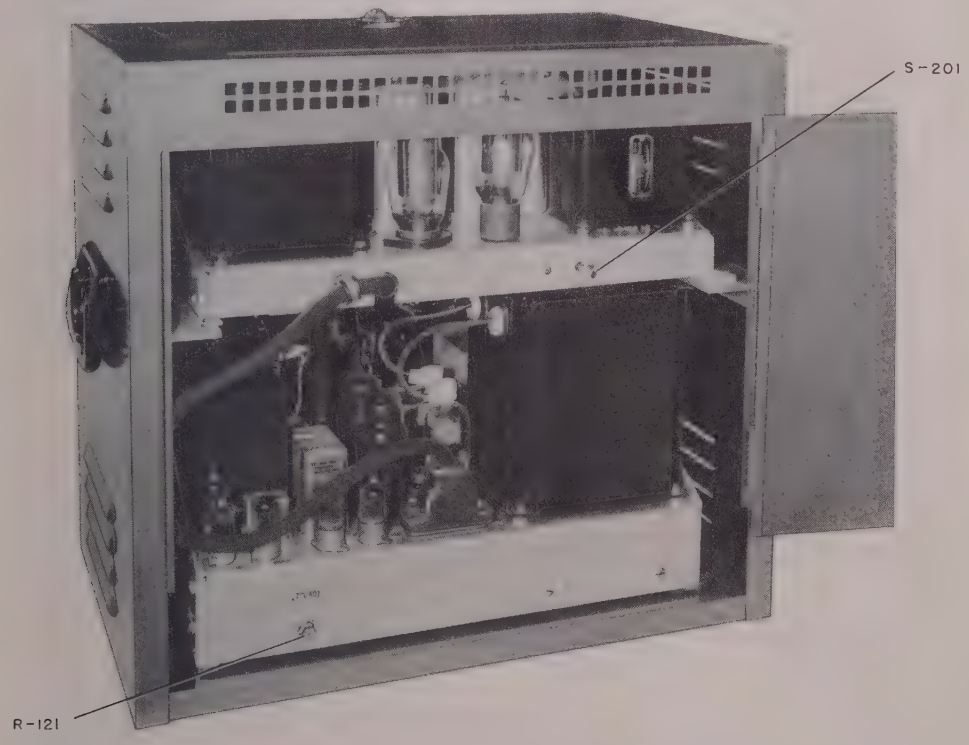


FIGURE 4-2 - MODEL 555 CABINET - BACK VIEW SHOWING CHASSIS OF BOTH DECKS

The beam-voltage adjustment is made as follows:

Throw both the POWER and BEAM switches on. Turn the front-panel BEAM VOLTAGE control knob (which adjusts potentiometers R-135, R-136, and R-137) to the extreme clockwise or counterclockwise position desired. If the reading on the BEAM VOLTAGE meter

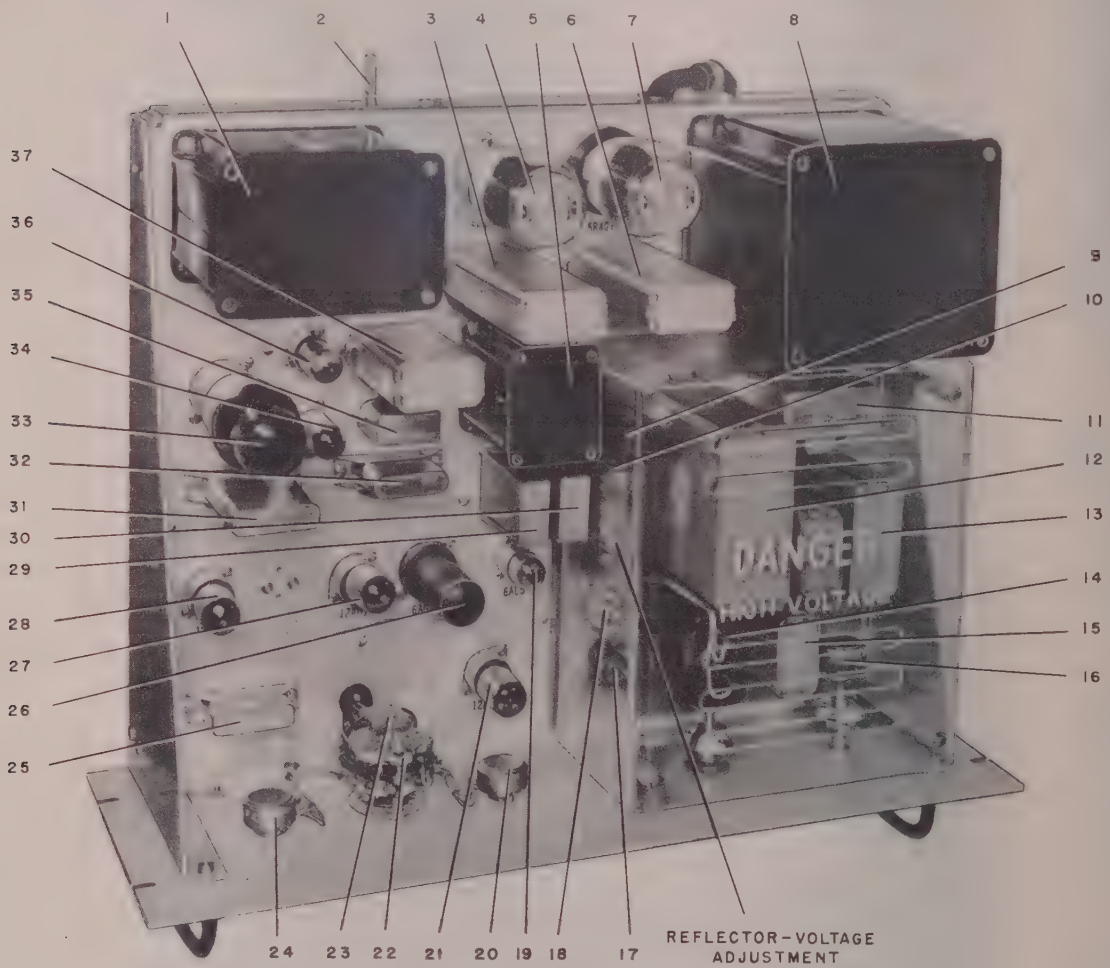


FIGURE 4-3 - MODULATOR-REFLECTOR CHASSIS - TOP VIEW

1. T-202	10. V-202	19. V-213	28. V-210
2. S-201	11. L-201	20. R-252	29. C-222
3. C-207	12. C-206	21. V-214	30. C-223
4. V-206	13. C-201	22. S-202	31. C-214
5. L-202	14. R-217	23. C-215	32. C-212
6. C-208	15. C-202	24. R-238	33. V-207
7. V-201	16. R-218	25. C-216	34. V-209
8. T-201	17. V-204	26. V-212	35. C-209
9. V-205	18. V-203	27. V-211	36. V-208

37. C-210

is not either -250 or -3600V (depending upon the position of the control knob), set it to the desired value by sufficient rotation of the shaft of the -175V ADJ potentiometer.

4-3b. REFLECTOR

If the reference tubes in the Reflector Supply are replaced or certain resistor values in this supply become altered, it may be necessary to readjust factory preset potentiometer R-214 (see figure 4-3) so that the voltage across C-205 becomes -1000 volts.

To make this adjustment, throw the POWER toggle switch on and the BEAM switch to OFF. With the REFLECTOR VOLTAGE panel control set at any position, turn the shaft of R-214 until the voltage between the terminals of C-205 reads -1000V. This measurement should be taken with an instrument rated at 1% accuracy, and having an internal resistance of at least 1000 ohms per volt.

4-4. TEST MEASUREMENTS

Test measurements provide a rapid means for the maintenance technician to locate many troubles which might occur in electronic equipment such as the Model 555. Tables I and II the tube pin-voltages and corresponding resistances for both decks are given here for comparison purposes when troubleshooting.

> WARNING
>
> The safest procedure when making these test-to-tube measurements is to connect the ground test lead to the chassis permanently so that only the red lead is used to perform the measurements.

4-4a. BEAM-SUPPLY DECK

Test measurements on the beam-supply deck are to be performed with the BEAM VOLTAGE meter on the front panel set to 1000V and a 80-milliampere load as indicated on the BEAM CURRENT meter. These measurements should be made using an instrument with an internal resistance of at least 1000 ohms per volt and a full-scale accuracy of 1%. The data for Table I was obtained with a Simpson Model 260 for the voltage measurements and a Volt-Ohmyst for the resistance values. Refer to figures 4-4 and 4-5 for the tube locations. Except where otherwise noted, all measurements are to be taken between ground and the designated point in the circuit.

To measure the beam ripple voltage, use an a-c vacuum-tube voltmeter or calibrated oscilloscope coupled to klystron panel jack J-104 (between pin H and pin D - ground) through an isolating capacitor of about 0.01 mfd and rated at 1000 volts or higher. Beam ripple voltage should not exceed 0.1000V rms under both no load and 80 milliamp load

conditions at any beam-voltage setting between -250 and -1250V. Neither should the 0.010V (rms) ripple be exceeded under no load and up to 15-ma loads at any voltage between -1250 and -3600V.

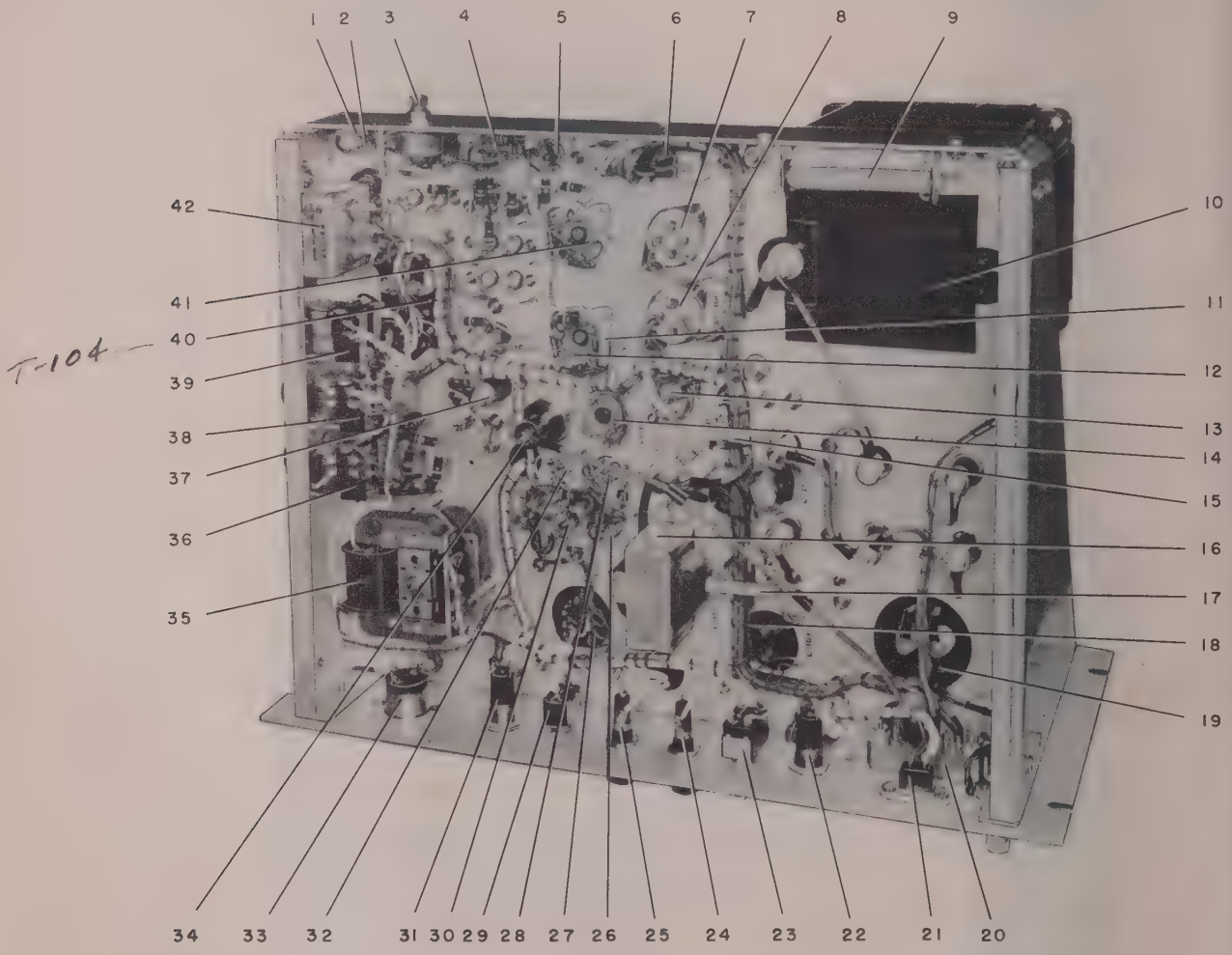


FIGURE 4-4 - BEAM-SUPPLY CHASSIS - BOTTOM VIEW

1.	C-107	12.	XV-112	22.	F-102	32.	XV-103
2.	XV-108	13.	K-103	23.	S-102	33.	J-102
3.	R-121	14.	XK-105	24.	F-102	34.	E-103
4.	XV-107	15.	R-138	25.	F-101	35.	B-101
5.	XV-113	16.	L-101	26.	XV-101	36.	K-101
6.	J-103	17.	R-133	27.	T-101	37.	C-111
7.	XV-110	18.	L-103	28.	XV-102	38.	K-102
8.	XV-109	19.	L-102	29.	S-101	39.	K-104
9.	R-101	20.	J-104	30.	XV-104	40.	T-104
10.	T-103	21.	J-101	31.	I-101	41.	XV-111
11.	C-113					42.	C-102 A & B

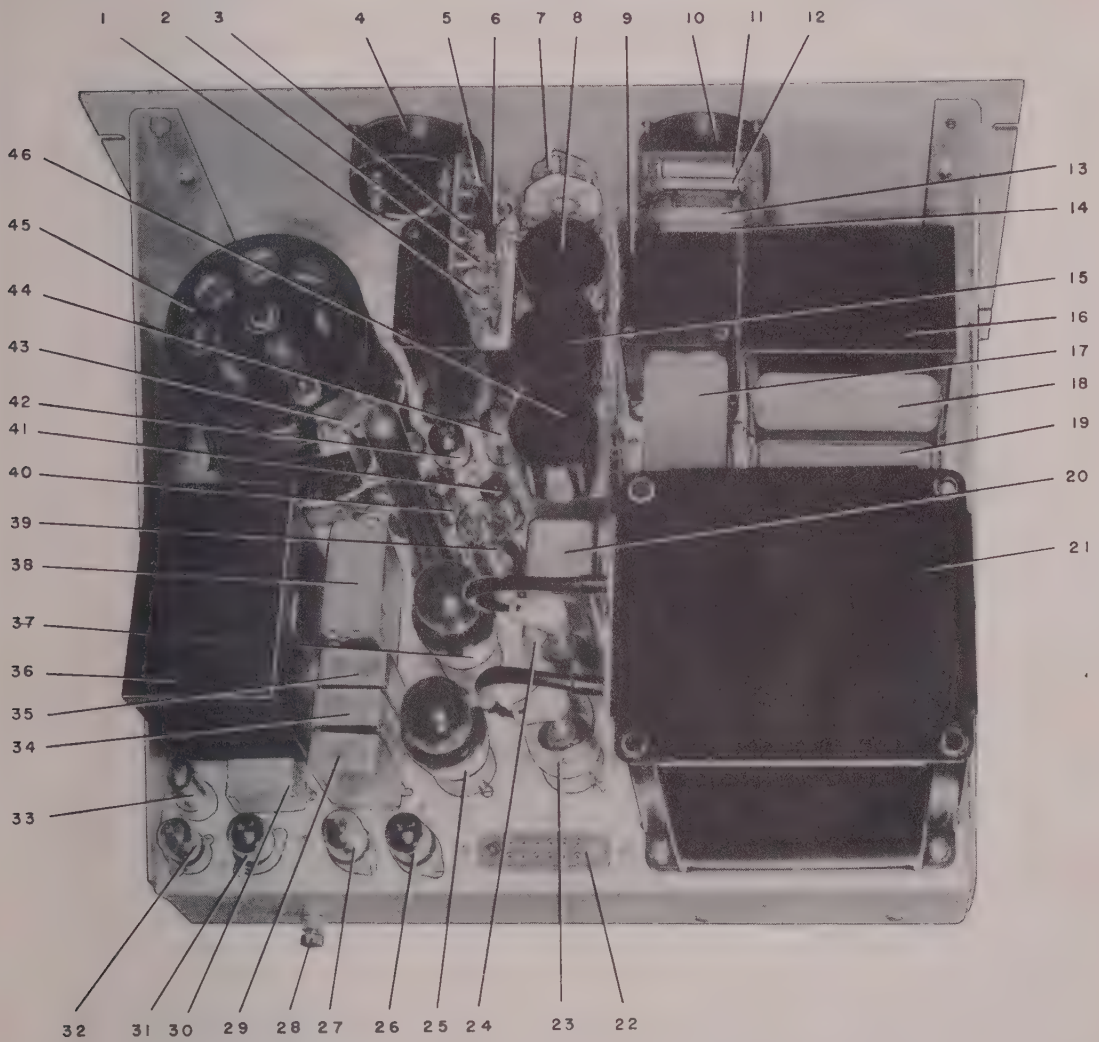


FIGURE 4-5 - BEAM-SUPPLY CHASSIS - TOP VIEW

1. R-111
2. R-112
3. R-113
4. M-101
5. R-114
6. C-103
7. S-104
8. R-135
9. L-103
10. M-102
11. R-139
12. R-140
13. R-141
14. R-142
15. R-136
16. L-102
17. C-112
18. C-110
19. C-109
20. K-103
21. T-103
22. J-103
23. V-110
24. V-109
25. V-111
26. V-113
27. V-107
28. R-121
29. C-108
30. C-106
31. V-106
32. V-108
33. V-105
34. C-105
35. C-104
36. T-104
37. V-112
38. C-111
39. K-105
40. V-103
41. V-102
42. V-104
43. S-103
44. V-101
45. T-102 — VARIAC
46. R-137

TABLE I

TEST MEASUREMENTS - BEAM-SUPPLY DECK

Tube Symbol	Pin No.	Nominal D-C Voltage	Resistance Ohms
V-101 (6X4)	1		1.5M
	3	+185	1.5M
	4	+185	1.5M
	6		1.5M
	7	+405	1.5M
V-102 (0B2)	1 or 5	+405	1.5M
	2,4, or 7	+290	∞
V-103 (0B2)	1 or 5	+290	∞
	2,4, or 7	+185	1.5M
V-104 (12AU7)	1	+360	1.5M
	2	+150	1.5M
	3	+185	1.5M
	4 or 5	+185	1.5M
	6	+360	1.5M
	7	+180	1.5M
	8	+185	1.5M
	9	+185	1.5M
V-105 (6X4)	1		.37M
	3	0	0

Tube Symbol	Pin No.	Nominal D-C Voltage	Resistance Ohms
V-105 (6X4)	4	0	0
	6		.37M
	7	+235	3.5M
V-106 (12AU7)	1	+210	3.5M
	2	-12.5	6M
	3,4,5	0	0
	6	+210	3.5M
	7	-12.5	6M
	8,9	0	0
V-107A&B (12AX7)	A(1	-12.5	6M
	A(2	-87	.2M
	A(3	-89	60K
	4 or 5	0	0
	B(6	-113	.35M
	B(7	-175	.4M
	B(8	-173	.4M
	9		0
V-108 (5651)	2	-175	.4M
	5	-88	56K
V-109 (3B24W)	CAP		60K*
	4	+270	1.5M

Tube Symbol	Pin No.	Nominal D-C Voltage	Resistance Ohms
V-110 (3B24W)	CAP		60K*
	4	+270	1.5M
V-111 (6L6GA)	2	0	0
	3	+230	1.5M
	4	+230	1.5M
	5&6	-22	2M
	7 or 8	0	0
V-112 (6L6)	2	0	0
	3	+230	1M
	4	+230	1M
	5&6	-23	2M
	7 or 8	0	0
V-113 (12AU7)	1	0	0
	2	-93	.22M
	3	-92	.5M
	4&5	0	0
	6	-22	2M
	7	-240	.35M
	8	0	0

* With BEAM VOLTAGE control at minimum (ccw)

Unless otherwise noted, all measurements are to be taken between ground and the designated point in the circuit.

4-4b. MODULATOR-REFLECTOR DECK

Test measurements on the modulator-reflector deck are to be performed with the POWER switch on, the BEAM switch off, the REFLECTOR VOLTAGE panel control set for -1000V, the Modulator AMPLITUDE control at full clockwise position, and the FREQUENCY and WAVE SHAPE controls also turned fully clockwise. The Modulator toggle switch is set to INT.

The data for Table II was obtained using a Volt-Ohmyst meter with the ground lead attached to pin H of klystron panel jack J-104 and with pin H shorted to the chassis (ground). Refer to figures 4-3 and 4-6 for the tube locations. Except where otherwise noted, all measurements are to be taken between pin H of J-104 and the designated point in the circuit.

To measure the reflector ripple voltage, use an a-c vacuum-tube voltmeter or a calibrated oscilloscope coupled through a suitable isolating capacitor (0.01 mfd, 1000V) to the klystron panel jack (J-104) between pins H and M. The reflector ripple voltage should not exceed 0.005V (rms) at any setting of the REFLECTOR VOLTAGE panel control.

To measure the control-electrode ripple voltage, use an a-c vacuum tube voltmeter or calibrated oscilloscope coupled through a suitable isolating capacitor (0.01 mfd, 1000V) to klystron panel jack J-104 between pins H and K. The control-electrode ripple voltage should not exceed 0.050V (rms) at any setting of the CONTROL ELECTRODE panel control.

PRECAUTION

Where minimum reflector and control-electrode ripple is required, it is recommended that adequate shielding be provided for these leads between the Model 555 front-panel jack and the klystron. This precaution is necessary because of the high impedance occurring at these output voltage terminals which increases the possibility of pickup of extraneous ripple-producing fields by the klystron electrode leads.

TABLE II

TEST MEASUREMENTS - MODULATOR-REFLECTOR DECK

Tube Symbol	Pin No.	Nominal D-C Voltage	Resistance Ohms
V-201 (5R4)	2&8	+390	90K
	4		130K
	6		130K
V-202 (12AU7)	1	+330	83K
	2	-20	2M
	3	0	0
	4&5	0	0
	6	+330	83K
	7	-20	2M
	8&9	0	0
V-203 (12AX7)	1	-20	2M
	2	-56	.55M
	3	-55	19K
	4&5	0	0
	6	-56	.55M
	7	-88	.19M
	8	-88	.8M
	9	0	0
V-204 (5651)	1 or 5	0	0
	4,2 or 7	-87	.8M
V-205 (6X4)	1	-1000	.36M
	3	0	0
	4	0	0
	6	-1000	.36M
	7	0	0
V-206 (5R4)	2	+670	2M
	4		20K
	6		20K
	8	+670	2M
V-207 (6L6GA)	2	+400	.19M
	3	+670	2M
	4	+670	2M
	5	+370	4M
	7	+400	.19M
	8	+400	.19M
V-208 (6AU6)	1	-2.1	.2M
	2	0	0
	3	0	0
	4	0	0
	5	+370	4M
	6	+64	.2M
	7	0	0
V-209 (0B2)	1 or 5	0	0
	2,4 or 7	-105	20K
V-210 (12AU7)	1	+360	.2M
	2	+76	.19M
	3	+94	.6M
	4 or 5	0	0
	6	+400	.19M
	7	-110	19K
	8	0	3.8
	9	0	0
V-211 (12AU7)	1	+80	.22M
	2	-.35	.45M
	3	0	0
	4 or 5	0	0
	6	+225	.21M
	7	-.3	.43M
	8	0	0
	9	0	0
V-212 (6AU7)	1 or 3	0	0
	2	0	0
	4	0	5K
	5	+2.85	27C
	6	+94	.6M
	7	0	0
	8	+195	.22M
V-213 (6AL5)	1	+295	1.1M
	2	+295	.55M
	3	0	0
	4	0	0
	5	+295	88
	7	+295	
V-214 (12AU7)	1	+400	.19M
	2	+160	.14M
	3	+175	30K
	4 or 5	0	0
	6	+400	.19M
	7	+160	.14M
	8	+175	30K
	9	0	0

Unless otherwise noted, all measurements are to be taken between pin H of J-104 and the designated circuit point.

4-5. MODULATOR TEST PATTERNS

The proper functioning of the Modulator can be further checked with an oscilloscope by examination of the circuit waveforms occurring at ten selected test-pattern points on the Modulator chassis. (Refer to figure 4-7.) In order to locate the designated points, refer to figure 4-6.

An oscilloscope with a linear time-base sweep should be used to perform these measurements. In each case the oscilloscope test leads should complete a circuit between the points indicated in figure 4-7 and ground (chassis). The test patterns observed on the oscilloscope should closely approximate those shown in the figure under the conditions listed on page 4-12.

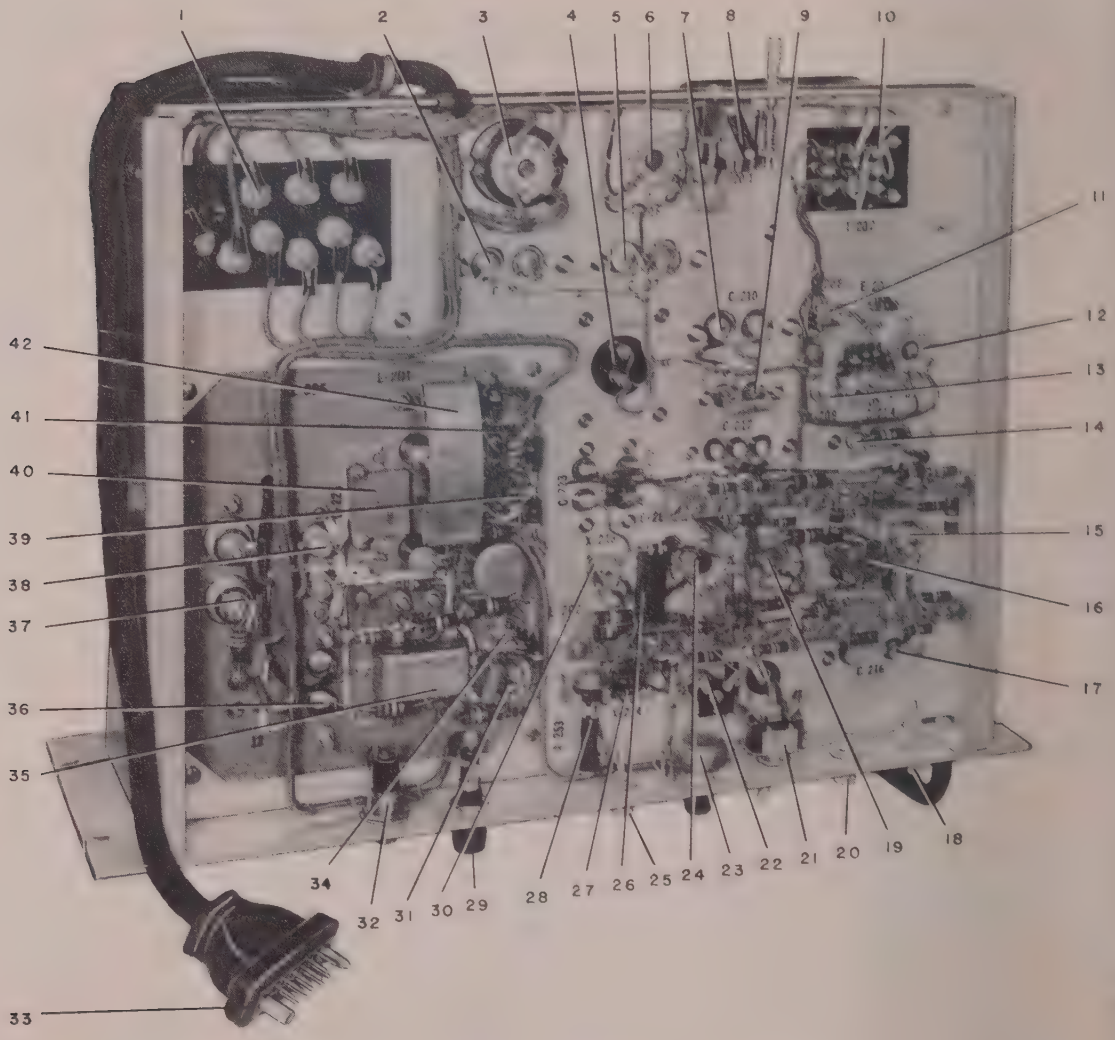


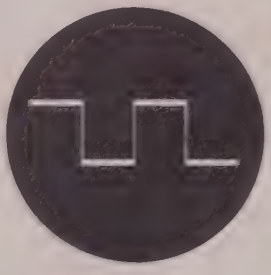
FIGURE 4-6 - MODULATOR-REFLECTOR CHASSIS - BOTTOM VIEW

1.	T-201	12.	XV-207	22.	L-203	32.	I-201
2.	C-208	13.	XV-209	23.	R-259	33.	P-201
3.	XV-201	14.	C-214	24.	XV-212	34.	XV-203
4.	L-202	15.	XV-210	25.	J-203	35.	C-204
5.	C-207	16.	T-203	26.	C-224	36.	C-202
6.	XV-206	17.	C-216	27.	XV-214	37.	C-201
7.	C-210	18.	J-201	28.	R-253	38.	C-205
8.	S-201	19.	XV-211	29.	F-201	39.	XV-202
9.	C-209	20.	J-202	30.	XV-213	40.	C-225
10.	T-202	21.	S-203	31.	XV-204	41.	XV-205
11.	XV-208					42.	E-201

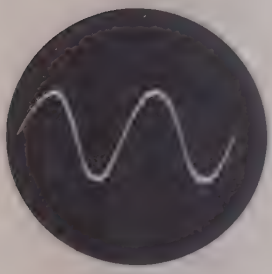
1 V-212, PIN 7

2 V-212, PIN 6

3 JUNCTION OF R-242 & R-243



4 V-212-PIN



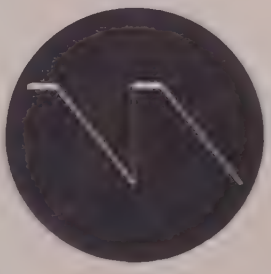
5A V-212, PIN 4, S-202 ON SINE WAVE

5B V-212, PIN 4, S-202 ON SQUARE WAVE

5C V-212, PIN 4, S-202 ON SAW-TOOTH WAVE

5A V-212, PIN 8, S-202 ON SINE WAVE

5B V-212, PIN 8 S-202 ON SQUARE WAVE



5C V-212, PIN 8, S-202 ON SAW-TOOTH WAVE

FIGURE 4-7 - MODULATOR TEST PATTERNS

a. Throw BEAM switch OFF.

b. Throw POWER switch ON.

c. Throw panel toggle switch to INT.

d. Set FREQUENCY control knob to mid-range (approx. 800 cps).

e. Set AMPLITUDE control knob almost to extreme ccw position (approx. 25V peak-to-peak).

f. WAVE SHAPE selector switch can be on any position for test patterns 1 through 4. Switch position is designated for remaining test patterns.

g. Oscilloscope sweep frequency should be adjusted to show at least one complete pattern.

4-6. SERVICE AND REPAIRS

Any servicing by the user beyond the scope of this Maintenance Section is not recommended, since it may seriously impair the performance of the instrument. Inquiries regarding the servicing, repair or operation of this Signal Source should be directed to Field Service Engineering Department, Sperry Gyroscope Company, Great Neck, New York. Do not return any unit before making this contact.

SECTION V
LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-1a. The following is the list of parts for the Model 555 Klystron Signal Source, manufactured by the Sperry Gyroscope Company, Division of The Sperry Corporation, Great Neck, New York.

5-1b. The Model 555 Klystron Signal Source consists of two major components, the Beam Supply (100-199 Reference Symbol Series) and the Reflector Supply and Modulator (200-299 Reference Symbol Series). Parts for each component are listed in alphabetical and numerical order by reference symbol. The reference symbol, which provides the necessary cross reference between the list of parts and the wiring schematics, consists of one or two letters of the alphabet followed by a three or four digit number. The letters indicate the type of part or piece of equipment, and the number denotes the component in which the part is located. The Alphabetical Symbol Key shown below provides a list of all the alphabetical symbols used throughout the list of parts.

5-2. ALPHABETICAL SYMBOL KEY

Symbol	Name of Part	Symbol	Name of Part
B	Motors	L	Chokes
C	Capacitors	M	Milliammeters, Voltmeters
E	Contacts, Posts, Terminals	P	Plugs
F	Fuses	R	Resistors
I	Lights	S	Switches
J	Connectors, Receptacles	T	Transformers
K	Relays	V	Tubes

5-1c. When ordering parts from the Sperry Gyroscope Company, the complete description, Sperry part number, and quantity desired must be given. Parts manufactured by sources other than the Sperry Gyroscope Company also show the manufacturer's code symbol and part number. A list of manufacturers showing the manufacturer's name, address, and code symbol is shown below. The list is arranged in alphabetical order by code symbol.

5-3. LIST OF MANUFACTURERS

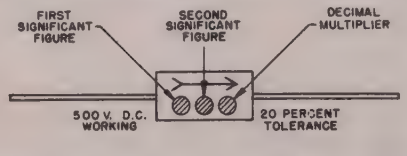
Symbol		Name and Address
AB	Allen Bradley Co.	Milwaukee, Wis.
AEV	Aerovox Corporation	New Bedford, Mass.
ALL	Allied Control Co., Inc.	New York, N. Y.
ALP	Alden Products Co.	Brockton, Mass.
AXS	Allmetal Screw Products Co.	New York, N. Y.
CUT	Cutler-Hammer, Inc.	Milwaukee, Wis.
EDI	Thomas A. Edison, Inc.	West Orange, N. J.
GE	General Electric Co.	Schenectady, N. Y.
HPT	Helipot Corp.	South Pasadena, Calif.

5-3. LIST OF MANUFACTURERS (Continued)

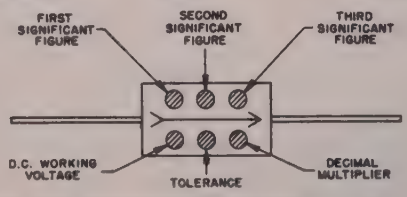
Symbol	Name and Address	
HYT	Hytron Corp.	Salem, Mass.
ICA	Insuline Corp. of America	Long Island City, N. Y.
INPR	Industrial Products Co.	Danbury, Conn.
KTC	Kenyon Transformer Co., Inc.	New York, N. Y.
LTF	Littlefuse, Inc.	Chicago, Ill.
MCS	Micro Switch Div.	Freeport, Ill.
MLL	James Millen Mfg. Co.	Malden, Mass.
MUE	Mueller Electric Co.	Cleveland, Ohio
RAY	Raytheon Mfg. Co.	Waltham, Mass.
RCA	Radio Corp. of America	New York, N. Y.
SGI	Sigma Instruments, Inc.	Boston, Mass.
SLE	Sylvania Electric Products, Inc.	New York, N. Y.
TBC	Thompson-Bremer and Co.	Chicago, Ill.
TBD	Tobe Deutschmann Corp.	Canton, Mass.
THE	Thordarson Electric Mfg. Div.	Chicago, Ill.
UNT	United Transformer Co., Industrial Div.	New York, N. Y.
WAL	Ward Leonard Electric Co.	Mount Vernon, N. Y.
WIQ	Winchester Electronics, Inc.	Glenbrook, Conn.

5-4. COLOR CODES FOR CAPACITORS AND RESISTORS

RMA COLOR CODES FOR CAPACITORS (MMFD)



COLOR	NUMERAL	VOLTS	MULTIPLIER	TOLERANCE
BLACK	0		1	
BROWN	1	100	10	1%
RED	2	200	100	2%
ORANGE	3	300	1,000	3%
YELLOW	4	400	10,000	4%
GREEN	5	500	100,000	5%
BLUE	6	600	1,000,000	6%
VIOLET	7	700	10,000,000	7%
GRAY	8	800	100,000,000	8%
WHITE	9	900	1,000,000,000	9%
GOLD		1000	0.1	5%
SILVER		2000	0.01	10%
NO COLOR		500		20%

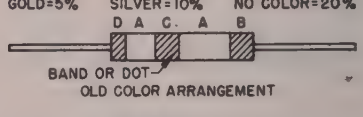


RMA COLOR CODE FOR RESISTORS (OHMS)

COLOR	A 1ST DIGIT	B 2ND DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D- TOLERANCE CODE

GOLD=5% SILVER=10% NO COLOR=20%



BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:,
BLACK - COMPOSITION, NON-INSULATED
TAN, OLIVE OR WHITE - COMPOSITION, INSULATED
DARK BROWN - WIRE-WOUND, INSULATED

5-5. BEAM SUPPLY

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Mfr. Designation
B-101	MOTOR, induction: 115v, 60 cps; 0.0002 hp; 6 rpm full load, 10 rpm no load; single phase, reversible rotation	714004		
C-101	CAPACITOR, fixed: paper dielectric; 1.0 mfd ±10%; 600 vdcw	037-5	AEV	CP61B1EF105K w/bracket CP06SA6
C-102A	CAPACITOR fixed: paper dielectric; 1.0-1.0 mfd +20%-10%; 600 vdcw	035-17	AEV	CP54B4EF105V
C-102B	CAPACITOR, fixed: Same as C-102A			
C-103	CAPACITOR, fixed: paper dielectric; 30,000 mmfd ±20%; 600 vdcw	0290-3	TBD	CN43A303M
C-104	CAPACITOR, fixed: Same as C-101			
C-105	CAPACITOR, fixed: Same as C-101			
C-106	CAPACITOR, fixed: paper dielectric; 0.1 mfd ±10%; 600 vdcw	037-2	AEV	CP61B1EF104K w/bracket CP06SA2
C-107	CAPACITOR, fixed: mica dielectric; 10,000 mmfd ±5%; 300 vdcw	0161-42		
C-108	CAPACITOR, fixed: Same as C-101			
C-109	CAPACITOR, fixed: acetate film dielectric; 1.0 mfd ±10%; 5,000 vdcw	713676-2		
C-110	CAPACITOR, fixed: acetate film dielectric; 1.0 mfd ±10%; 4,000 vdcw	713761		
C-111	CAPACITOR, fixed: acetate film dielectric; 0.1 mfd ±10%; 4,000 vdcw	713686		
C-112	CAPACITOR, fixed: acetate film dielectric; 2.0 mfd ±10%; 4,000 vdcw	713676-1		
C-113	CAPACITOR, fixed: mica dielectric; 200 mmfd ±5%; 500 vdcw	0155-39	AEV	CM20B201J
E-101	POST, binding: nickel plated brass body, black phenolic symbol disc; No. 8-32 thread; marked "GND"	837038-02	ICA	631
E-102	TERMINAL, soldering: locking type; brass or bronze; 3/8" wide x 3/4" long x 0.020" thick	093-9	TBC	320
F-101	FUSE: single element, glass tube; 8 amps, 250 v	042-14	LTF	312008
F-102	FUSE: single element, glass tube; 5 amps, 250 v	042-12	LTF	312005
I-101	LIGHT, indicator: neon; crystal lens, smooth faced clear; miniature bayonet base; 115 v	264218-7		
I-102	LIGHT, indicator: neon; red lens, smooth faced clear; miniature bayonet base; 115 v	264218-1		
J-101	CONNECTOR, female contact: 2 contacts; 10 amps-250 v, 15 amps-125 v	838029	ALP	402-ACF w/solder dipped terminals
J-102	CONNECTOR, male contact: 2 contacts; 10 amps, 250 v; 15 amps, 125 v	195232	GE	2711
J-103	RECEPTACLE, female contact: 12 contacts; 500 vac (R.M.S.)	826767	WIQ	RE-12S
J-104	RECEPTACLE, female contact: Same as J-103			
K-101	RELAY, solenoid: DPDT; 10 amps-32 vdc, 115 vac	816753		
K-102	RELAY, solenoid: same as K-101			
K-103	RELAY, armature: SPDT; 3 amps - 26.5 vdc, 115 vac	822716	SGI	4RJ Spec 75939
K-104	RELAY, solenoid: DPDT: 15 amps - 32 vdc, 15 amps - 115 vac	812957	ALL	Box-102
K-105	RELAY, thermal: SPST; 3 amps - 250 vac, 150 vdc	823786	EDI	B1625
L-101	CHOKE, filter: 75 henries, 5 ma; 350 henries, 25 ma; 5,500 ohms dc resistance	827852-1	THE	T20C50
L-102	CHOKE, filter: 6 henries, 130 ma; 21 henries, 30 ma; 220 ohms ± 15% dc resistance	713967	KTC	S26035

5-5. BEAM SUPPLY (Continued)

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Mfr. Designation
L-103	CHOKE, filter: 12.5 henries, 130 ma; 220 ohms ± 15% dc resistance	713976	KTC	S26036
M-101	MILLIAMMETER, dc; 150 ma range; ±2% full scale deflection at 25°C; full scale terminal drop - 150 mv	710893-24	GE	DO-71
M-102	VOLTMETER, dc: 0 to 4,000 vdc range; ±2% full scale deflection; 1,000 ohms per volt	714275		
R-101	RESISTOR, fixed: wire wound; 6,300 ohms ±5%; 18 W	0102-97	WAL	RW33G632
R-102	RESISTOR, fixed: composition; 0.12 meg ±5%; 1 W	813188-99	AB	GB-1245
R-103	RESISTOR, fixed: composition; 30,000 ohms ±5%; 1 W	813188-84	AB	GB-3035
R-104	RESISTOR, fixed: composition; 0.51 meg ±5%; 1/2 W	813186-114	AB	EB-5145
R-105	RESISTOR, fixed: Same as R-104			
R-106	RESISTOR, fixed: composition; 0.16 meg ±5%; 1 W	813188-102	AB	GB-1645
R-107	RESISTOR, fixed: composition; 75,000 ohms ±5%; 1 W	813188-94	AB	GB-7535
R-108	RESISTOR, fixed: Same as R-107			
R-109	RESISTOR, fixed: composition; 0.24 meg ±5%; 1 W	813188-106	AB	GB-2445
R-110	RESISTOR, fixed: composition; 0.75 meg ±5%; 1 W	813188-118	AB	GB-7545
R-111	RESISTOR, fixed: Nobleloy; 550 ohms ±1%; 1 W	288376-08		
R-112	RESISTOR, fixed: Nobleloy; 225 ohms ±1%; 1 W	288376-09		
R-113	RESISTOR, fixed: Nobleloy; 150 ohms ±1%; 1 W	288376-10		
R-114	RESISTOR, fixed: Nobleloy; 75 ohms ±1%; 2 W	714417-01		
R-115	RESISTOR, fixed: composition; 2.0 meg ±5%; 1 W	813188-128	AB	GB-2055
R-116	RESISTOR, fixed: composition; 3.3 meg ±5%; 1 W	813188-133	AB	GB-3355
R-117	RESISTOR, fixed: composition; 470 ohms ±5%; 1/2 W	813186-41	AB	EB-4715
R-118	RESISTOR, fixed: Same as R-117			
R-119	RESISTOR, fixed: composition; 51,000 ohms ±5%; 1 W	813188-90	AB	GB-5135
R-120	RESISTOR, fixed: Same as R-102			
R-121	RESISTOR, variable: composition; 100,000 ohms ±20%; 2 W	0192-73	AB	J1U1042SD3048
R-122	RESISTOR, fixed: composition; 0.15 meg ±5%; 1 W	813188-101	AB	GB-1545
R-123	RESISTOR, fixed: composition; 10,000 ohms ±5%; 1 W	813188-73	AB	GB-1035
R-124	RESISTOR, fixed: composition; 22 ohms ±5%; 1 W	813186-9	AB	EB-2205
R-125	RESISTOR, fixed: Same as R-124			
R-126	RESISTOR, fixed: composition; 1.00 meg ±5%; 1 W	813188-121	AB	GB-1055
R-127	RESISTOR, fixed: Same as R-117			
R-128	RESISTOR, fixed: Same as R-117			
R-129	RESISTOR, fixed: composition; 0.20 meg ±5%; 1 W	813188-104	AB	GB-2045
R-130	RESISTOR, fixed: Same as R-122			
R-131	RESISTOR, fixed: composition; 68,000 ohms ±5%; 1 W	813188-93	AB	GB-6835
R-132	RESISTOR, fixed: composition; 0.30 meg ±5%; 1 W	813188-108	AB	GB-3045
R-133	RESISTOR, fixed: Nobleloy; 38,700 ohms ±1%; 2 W	714417-02		
R-134	RESISTOR, fixed: Same as R-132			

5-5. BEAM SUPPLY (Continued)

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Mfr. Designation
R-135	RESISTOR, variable: wire wound; 250,000 ohms ±5%; 5 W	715545		
R-136	RESISTOR, variable: Same as 135			
R-137	RESISTOR, variable: Same as 135			
R-138	RESISTOR, fixed: Nobleloy; 16,000 ohms ±1%; 1W	288376-06		
R-139	RESISTOR, fixed: Nobleloy; 1.0 meg ±1%; 2W	714417-03		
R-140	RESISTOR, fixed: Same as R-139			
R-141	RESISTOR, fixed: Same as R-139			
R-142	RESISTOR, fixed: Same as R-139			
R-143	RESISTOR, fixed: Same as R-123			
R-144	RESISTOR, fixed: composition, 3.3K ±5%; 1W	813188-61	AB	GB-3325
S-101	SWITCH, toggle: SPST	0232-1	CUT	ST42A
S-102	SWITCH, toggle: DPST	0233-1	CUT	ST52K
S-103	SWITCH, micro: SPDT; 10 amps - 125 or 250 vdc, 0.25 amps - 250 vdc, 0.5 amps - 125 vdc, 10 amps - 28.5 vdc	264217	MCS	V3-1
S-104	SWITCH, rotary: 1 section, 1 pole, 4 positions; 300 vac (RMS), 300 vdc; 10 amps ac or dc	714048		
T-101	TRANSFORMER, plate: primary winding 115v 60 cycles per second; two output windings, No. 1 secondary 400-0-400 v ±5% full wave rectified load of 30 ma dc unfiltered, No. 2 secondary winding 6.3 v ±1% at 1 amp	713964	KTC	S26234
T-102	AUTOTRANSFORMER, variable: primary winding 115 v 50/60 cycles per second; single phase; No. 1 secondary 0-135 v at 7.5 amps	672890		
T-103	TRANSFORMER, plate: primary winding 115 v 60 cycles per second; two output windings, No. 1 secondary 3500-0-3500 v ±5% at 25 ma, No. 2 secondary 2000-0-2000 v ±5% at 95 ma with a primary voltage of 66 v	672832	KTC	S-26034
T-104	TRANSFORMER, plate: primary winding 115 v 60 cycles per second; three output windings, No. 1 secondary 300-0-300 v ±3% at 10 ma, No. 2 secondary 6.3 v ±3% at 3.5 amps, No. 3 secondary 5 v ±3% at 6 amps	713983	KTC	S-26033
V-101	TUBE, electron: full wave high vacuum rectifier; type 6X4	820102-2	GE	6X4
V-102	TUBE, electron: miniature voltage regulator; type OB2	818236-2	HYT	OB2
V-103	TUBE, electron: Same as V-102			
V-104	TUBE, electron: twin triode amplifier; type 12AU7	820151-2	GE	12AU7
V-105	TUBE, electron: Same as V-101			
V-106	TUBE, electron: Same as V-104			
V-107	TUBE, electron: high mu twin triode amplifier; type 12AX7	823494-2	GE	12AX7
V-108	TUBE, electron: voltage reference tube; type 5651	823668-2	RCA	5651
V-109	TUBE, electron: half wave high vacuum rectifier; type 3B24W	818179-2	RAY	3B24W
V-110	TUBE, electron: Same as V-109			
V-111	TUBE, electron: beam power amplifier receiving; type 6L6GA	805985-2	SLE	6L6GA
V-112	TUBE, electron: Same as V-111			
V-113	TUBE, electron: Same as V-104			

5-6. REFLECTOR SUPPLY AND MODULATOR

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Mfr. Designation
C-201	CAPACITOR, fixed: paper dielectric; 0.5 mfd +20%-10%; 2,000 vdcw	041-23	AEV	CP70E1EJ504V w/bracket CP07SB2
C-202	CAPACITOR, fixed: paper dielectric; 0.5 mfd +20% -10%; 1,500 vdcw	041-3	AEV	CP70B1EH504V w/bracket CP07SA3
C-203	CAPACITOR, fixed: Same as C-107			
C-204	CAPACITOR, fixed: paper dielectric; 0.1 mfd ±10%; 1,000 vdcw	034-32	AEV	CP53B1EG104K
C-205	CAPACITOR, fixed: paper dielectric; 2.0 mfd +20% -10%; 1,000 vdcw	040-25	AEV	CP70B1EG205V w/bracket CP07SA6
C-206	CAPACITOR, fixed: Same as C-109			
C-207	CAPACITOR, fixed: Same as C-205			
C-208	CAPACITOR, fixed: Same as C-205			
C-209	CAPACITOR, fixed: Same as C-106			
C-210	CAPACITOR, fixed: paper dielectric; 2.0 mfd +20% -10%; 600 vdcw	040-5	AEV	CP70B1EF205V w/bracket CP07SA4
C-211	CAPACITOR, fixed: mica dielectric; 100 mmfd ±5%; 500 vdcw	0155-32	AEV	CM20B101J
C-212A	CAPACITOR, fixed: paper dielectric; 0.1-0.1 mfd +20% -10%; 600 vdcw	039-42	AEV	CP69B4EF104V
C-212B	CAPACITOR, fixed: Same as C-212A			
C-213	CAPACITOR, fixed: mica dielectric; 9,100 mmfd ±5%; 300 vdcw	0161-27	AEV	CM35B912J
C-214A	CAPACITOR, fixed: paper dielectric; 0.5-0.5 mfd +20% -10%; 600 vdcw	039-44	AEV	CP69B4EF504V
C-214B	CAPACITOR, fixed: Same as C-214A			
C-215	CAPACITOR, fixed: mica dielectric; 2,400 mmfd ±5%; 500 vdcw	0161-13	AEV	CM30B242J
C-216	CAPACITOR, fixed: paper dielectric; 0.05 mfd ±10%; 600 vdcw	039-31	AEV	CP69B1EF503K
C-217	CAPACITOR, fixed: mica dielectric; 1,000 mmfd ±5%; 500 vdcw	0161-4	AEV	CM30B102J
C-218	CAPACITOR, fixed: mica dielectric; 510 mmfd ±5%; 500 vdcw	0155-49	AEV	CM20B511J
C-219	CAPACITOR, fixed: mica dielectric; 51 mmfd ±5%; 500 vdcw	0155-25	AEV	CM20B510J
C-220	CAPACITOR, fixed: Same as C-219			
C-221	CAPACITOR, fixed: mica dielectric; 75 mmfd ±5%; 500 vdcw	0155-29	AEV	CM20B750J
C-222	CAPACITOR, fixed: Same as C-101			
C-223	CAPACITOR, fixed: Same as C-101			
C-224	CAPACITOR, fixed: paper dielectric; 100,000 mmfd ±20%; 400 vdcw	0290-5	TBD	CN43E104M
C-225	CAPACITOR, fixed: mica dielectric; 1,000 mmfd ±10%; 2,500 vdcw	018-5	AEV	CM45B102K
E-201	CONTACT, spring: 0.100 thick beryllium copper; 3-7/8" long x 1-1/8" wide x 3/4" thick	838574		
F-201	FUSE: single element: glass tube; 2 amps, 250 v	042-09	LTF	312002
I-201	LIGHT, indicator: Same as I-102			
J-201	CONNECTOR, female contact: 1 contact; 500 v maximum operating voltage	714245	INPR	UG-625/U
J-202	CONNECTOR, female contact: Same as J-201			
J-203	CONNECTOR, female contact: Same as J-201			
L-201	CHOKE, filter: Same as L-101			
L-202	CHOKE, filter: 9 henries, 50 ma; 200 ohms ±20% dc resistance	824121	KTC	S23910

5-6. REFLECTOR SUPPLY AND MODULATOR (Continued)

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Mfr. Designation
L-203	CHOKE ASSEMBLY: No. 39 A.W.G. wire, 1100 turns per pie, 2,200 total turns; 230.4 ohms ±15% dc resistance	824234		
P-201	PLUG, male contact: 12 contacts; 500 vac (R.M.S.)	826768	WIQ	RE12P
R-201	RESISTOR, fixed: composition; 0.15 meg ±5%; 2 W	813190-101	AB	HB-1545
R-202	RESISTOR, fixed: Same as R-201			
R-203	RESISTOR, fixed: Same as R-117			
R-204	RESISTOR, fixed: Same as R-117			
R-205	RESISTOR, fixed: Same as R-115			
R-206	RESISTOR, fixed: composition; 9.1 meg ±5%; 1 W	813188-144	AB	GB-9155
R-207	RESISTOR, fixed: composition; 18,000 ohms ±5%; 1 W	813188-79	AB	GB-1835
R-208	RESISTOR, fixed: Same as R-201			
R-209	RESISTOR, fixed: Same as R-201			
R-210	RESISTOR, fixed: composition; 0.51 meg ±5%; 1 W	813188-114	AB	GB-5145
R-211	RESISTOR, fixed: composition; 0.27 meg ±5%; 2 W	813190-107	AB	HB-2745
R-212	RESISTOR, fixed: Same as R-211			
R-213	RESISTOR, fixed: composition; 0.18 meg ±5%; 1 W	813188-103	AB	GB-1845
R-214	RESISTOR, variable: composition; 350,000 ohms ±20%; 2 W	0192-106	AB	J1U3542SD3056
R-215	RESISTOR, fixed: composition; 0.82 meg ±5%; 1 W	813188-119	AB	GB-8245
R-216	RESISTOR, fixed: composition; 0.91 meg ±5%; 1 W	813188-120	AB	GB-9145
R-217	RESISTOR, variable: wire wound; 250,000 ohms ±2%; 5 W	715545		
R-218	RESISTOR, variable: composition; 350,000 ohms ±20%; 2 W	0192-16	AB	J1U3542P3056
R-219	RESISTOR, fixed: Same as R-132			
R-220	RESISTOR, fixed: Same as R-129			
R-221	RESISTOR, fixed: composition; 0.33 meg ±5%; 1 W	813188-109	AB	GB-3345
R-222	RESISTOR, fixed: Same as R-115			
R-223	RESISTOR, fixed: Same as R-124			
R-224	RESISTOR, fixed: Same as R-117			
R-225	RESISTOR, fixed: composition; 0.62 meg ±5%; 1 W	813188-116	AB	GB-6245
R-226	RESISTOR, fixed: composition; 1.6 meg ±5%; 1 W	813188-126	AB	GB-1655
R-227	RESISTOR, fixed: Same as R-129			
R-228	RESISTOR, fixed: Nobleloy; 200,000 ohms ±1%; 1 W	288376-03		
R-229	RESISTOR, fixed: composition; 18,000 ohms ±5%; 2 W	813190-79	AB	HB-1835
R-230	RESISTOR, fixed: Nobleloy; 750,000 ohms ±1%; 1 W	288376-07		
R-232	RESISTOR, fixed: Same as R-215			
R-233	RESISTOR, fixed: Same as R-129			
R-234	RESISTOR, fixed: composition; 10,000 ohms ±5%; 2 W	813190-73	AB	HB-1035
R-235	RESISTOR, fixed: composition; 1,000 ohms ±5%; 1 W	813188-49	AB	GB-1025

5-6. REFLECTOR SUPPLY AND MODULATOR (Continued)

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Mfr. Designation
R-236	RESISTOR, fixed: Same as R-123			
R-237	RESISTOR, fixed: Same as R-110			
R-238	RESISTOR, variable: composition; 1,000,000 ohms ±20%; 2 W	0192-19	AB	J1U1052P3056
R-239	RESISTOR, fixed: Same as R-210			
R-240	RESISTOR, fixed: Same as R-126			
R-241	RESISTOR, fixed: composition; 20,000 ohms ±5%; 2 W	813190-80	AB	HB-2035
R-242	RESISTOR, fixed: Same as R-241			
R-243	RESISTOR, fixed: Same as R-241			
R-244	RESISTOR, fixed: Same as R-126			
R-245	RESISTOR, fixed: Same as R-210			
R-246	RESISTOR, fixed: Same as R-123			
R-247	RESISTOR, fixed: composition; 6,800 ohms ±5%; 1 W	813188-69	AB	GB-6825
R-248	RESISTOR, fixed: Same as R-210			
R-249	RESISTOR, fixed: Same as R-110			
R-250	RESISTOR, fixed: composition; 36,000 ohms ±5%; 1 W	813188-86	AB	GB-3635
R-251	RESISTOR, fixed: composition; 0.22 meg ±5%; 1 W	813188-105	AB	GB-2245
R-252	RESISTOR, variable: composition; 100,000 ohms ±20%; 2 W	0192-13	AB	J1U1042P3056
R-253	RESISTOR, fixed: wire wound; 20,000 ohms ±10%; 10 W	283208	WAL	211
R-254	RESISTOR, fixed: Same as R-235			
R-255	RESISTOR, fixed: composition; 240 ohms ±5%; 1 W	813188-34	AB	GB-2415
R-256	RESISTOR, fixed: Same as R-210			
R-257	RESISTOR, fixed: Same as R-132			
R-256	RESISTOR, fixed: Same as R-241			
R-259	RESISTOR, variable: Same as R-252			
R-260	RESISTOR, fixed: Same as R-126			
R-261	RESISTOR, fixed: composition; 2,000 ohms ±5%; 1 W	813188-56	AB	GB-2025
R-262	RESISTOR, fixed: composition; 51,000 ohms ±5%; 2 W	813190-90	AB	HB-5135
R-263	RESISTOR, fixed: Same as R-262			
S-201	SWITCH, interlock: SPDT; 10 amps - 125 or 250 vac, 1/2 amp - 125 vdc, 1/4 amp - 250 vdc	713683	MCS	3AC2
S-202A	SWITCH, rotary: 2 sections, 6 poles, 3 positions; 300 vac (RMS), 300 vdc; 10 amps ac or dc	824194		
S-202B	SWITCH, rotary: Same as S-202A			
S-203	SWITCH, toggle: SPDT	0232-4	CUT	ST42D
T-201	TRANSFORMER, power: primary winding 115 v 60 cycles per second; four output windings, No. 1 secondary 1060-0-1060 v ±3% at 12 ma, No. 2 secondary 5 v ±3% at 2 amps, No. 3 secondary 6.3 v ±3% at 1.2 amps, No. 4 secondary 6.3 v ±3% at 2 amps	713968	KTC	S26037
T-202	TRANSFORMER, power: primary winding 115 v 60 cycles per second; four output windings, No. 1 secondary 580-0-580 v ±3% at 55 ma, No. 2 secondary 6.3 v ±3% at 2.2 amps, No. 3 secondary 5 v ±3% at 2 amps, No. 4 secondary 6.3 v ±3% at 1 amp	714307	KTC	S26418

5-6. REFLECTOR SUPPLY AND MODULATOR (Continued)

Ref. Symbol	Name and Description	Sperry Part Number	MFR.	Designation
T-203	TRANSFORMER, blocking oscillator: primary inductance 0.13 henries at 2.5 v (R.M.S.) 300 cycles per second, power level 50 milliwatts	824120	UNT	88662S
V-201	TUBE, electron: full wave high-vacuum rectifier; type 5R4GY	805147-2	GE	5R4GY
V-202	TUBE, electron: Same as V-104			
V-203	TUBE, electron: Same as V-107			
V-204	TUBE, electron: Same as V-108			
V-205	TUBE, electron: Same as V-101			
V-206	TUBE, electron: Same as V-201			
V-207	TUBE, electron: Same as V-111			
V-208	TUBE, electron: miniature R-F pentode; type 6AU6	821157-2	GE	6AU6
V-209	TUBE, electron: Same as V-102			
V-210	TUBE, electron: Same as V-104			
V-211	TUBE, electron: Same as V-104			
V-212	TUBE, electron: power amplifier pentode; type 6AG7	808057	GE	6AG7
V-213	TUBE, electron: very high frequency twin diode; type 6AL5	814029-2	GE	6AL5
V-214	TUBE, electron: Same as V-104			
	CABLE ASSEMBLY	673530		
E-310	CLIP	191866	MLL	36002
	INSULATOR, Rubber	284824-2	MUE	47
E-311	CONNECTOR, CLIP	289451	MUE	45C
XV-301	SOCKET	850207		
	ADHESIVE LABEL	850248		
	HOOD, Connector	838163	WIQ	12P-HN
P-304	PLUG, Male Contacts	826768	WIQ	RE12P

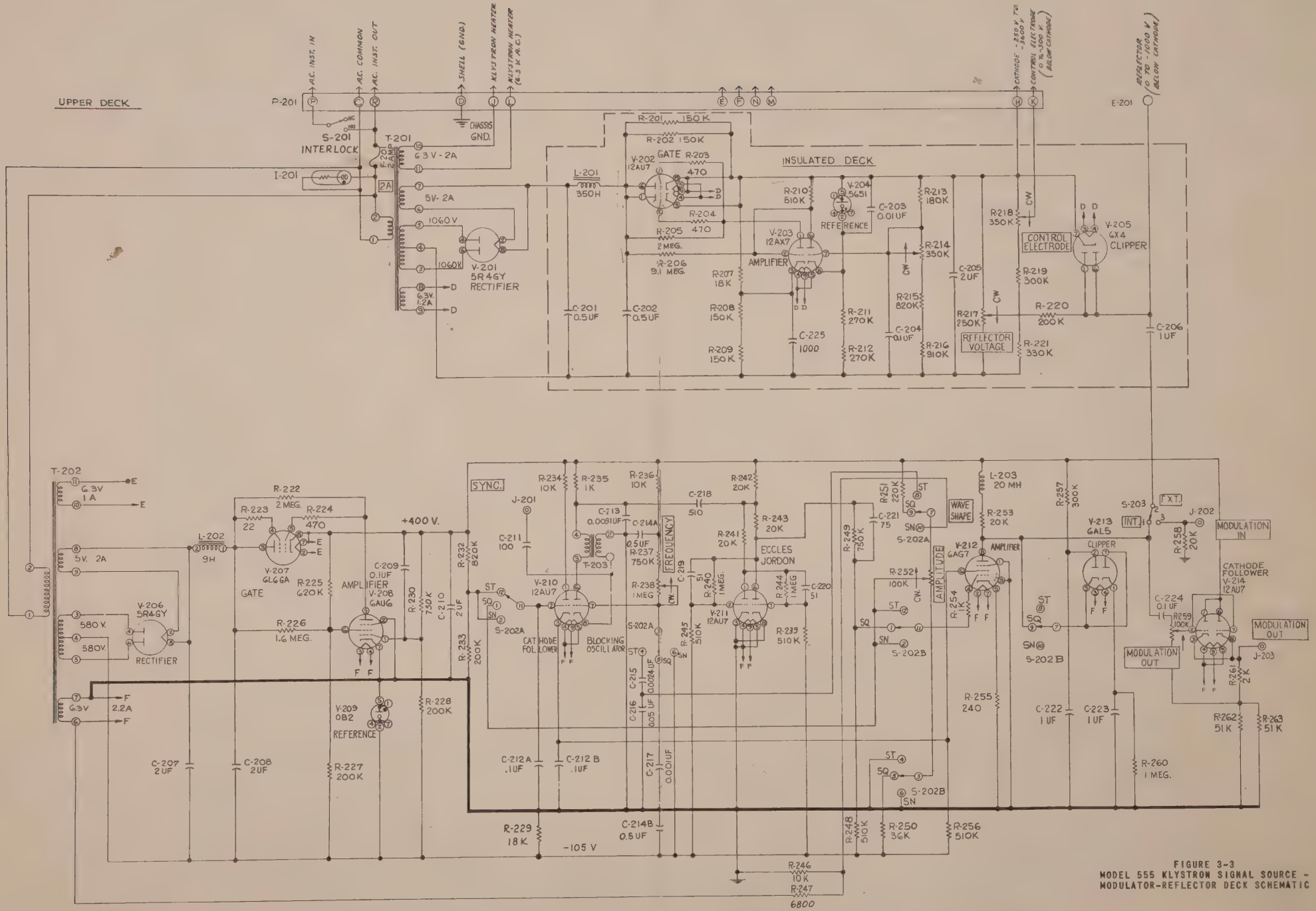
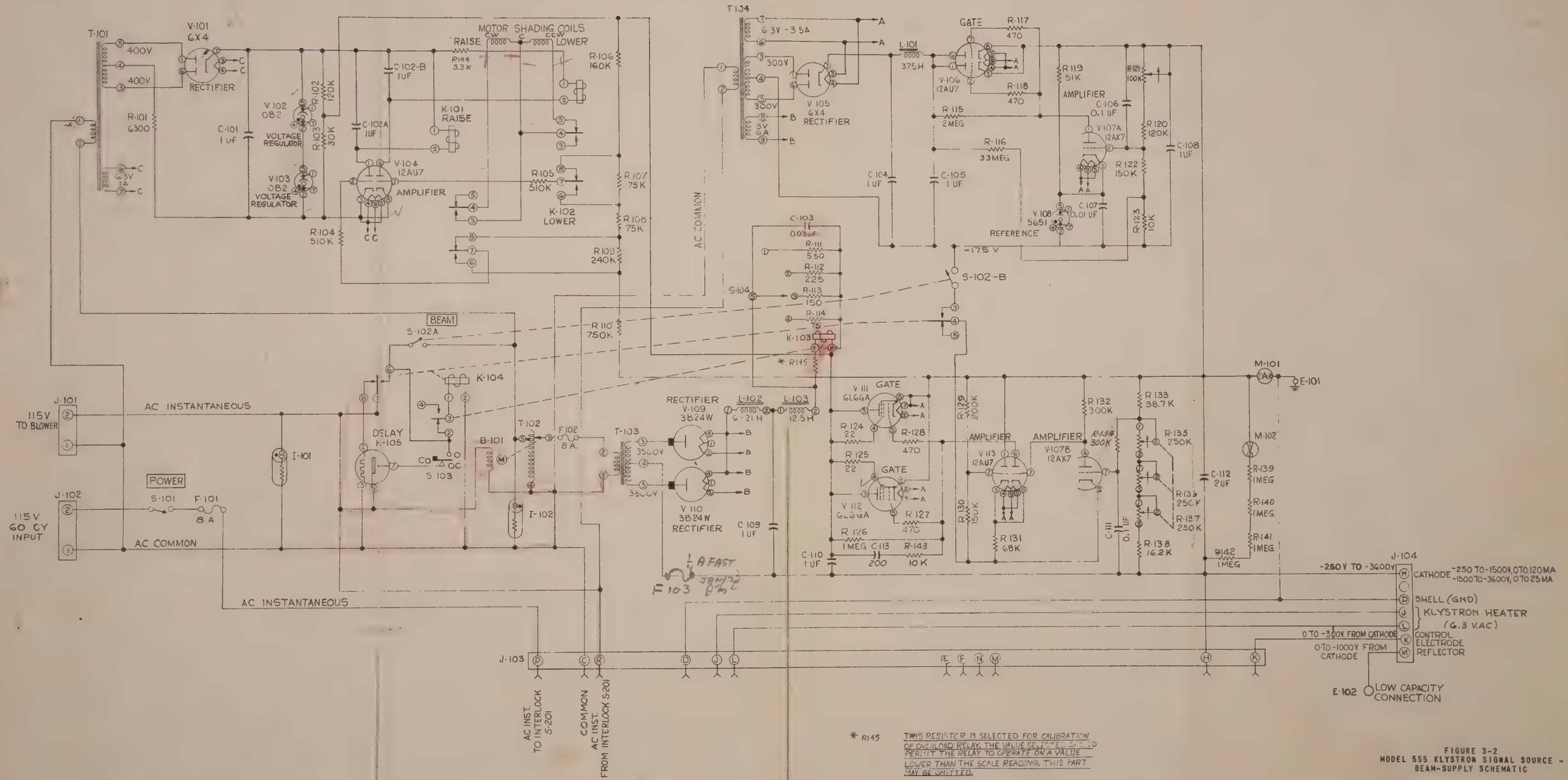


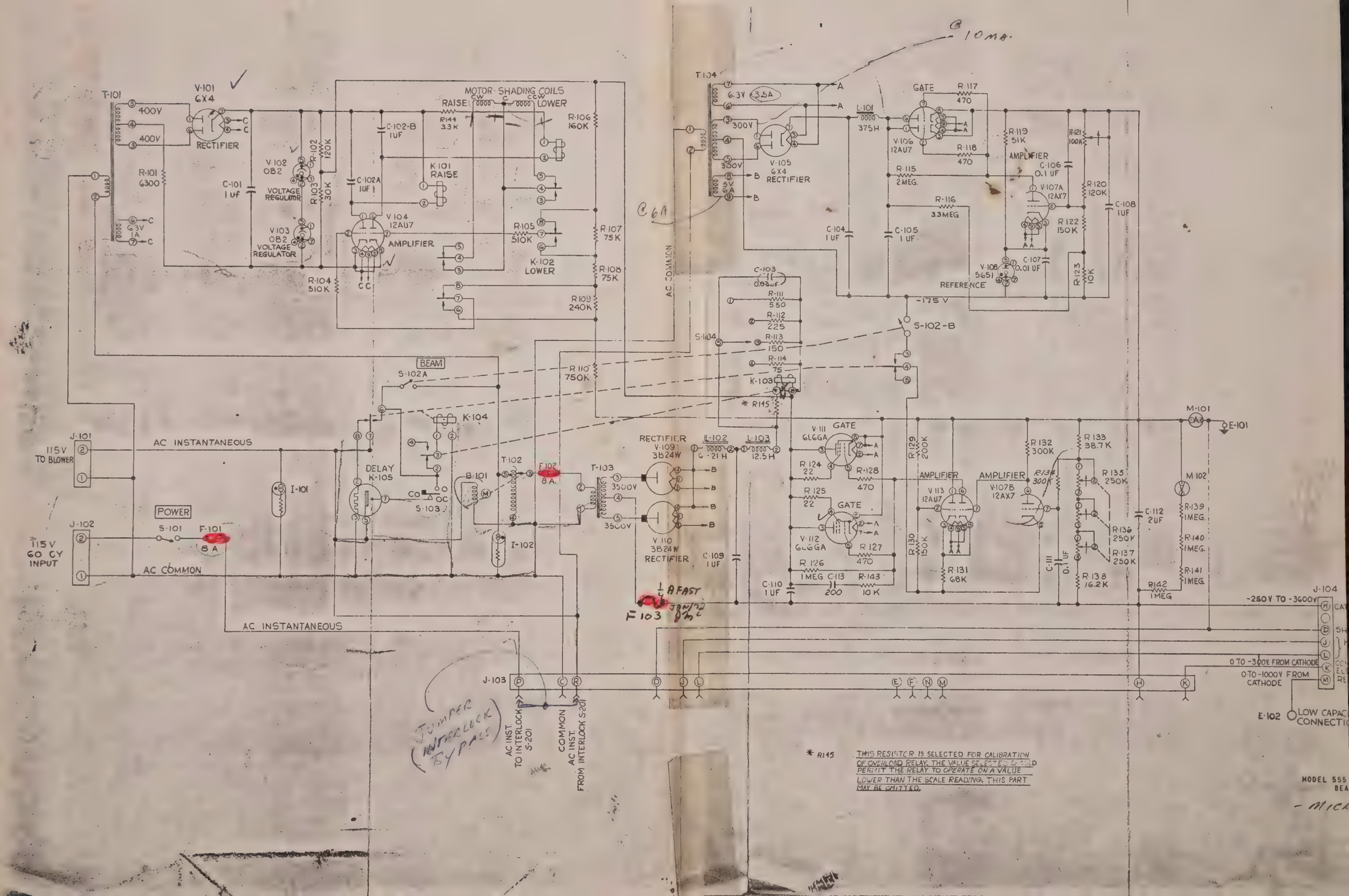
FIGURE 3-3
MODEL 555 KLYSTRON SIGNAL SOURCE - MODULATOR-REFLECTOR DECK SCHEMATIC



* R145 THIS RESISTOR IS SELECTED FOR CALIBRATION OF OVERLOAD RELAY. THE VALUE SELECTED SHALL PERMIT THE RELAY TO OPERATE ON A VALUE LOWER THAN THE SCALE READING. THIS PART MAY BE OMITTED.

FIGURE 3-2
MODEL 555 KLYSTRON SIGNAL SOURCE - BEAM-SUPPLY SCHEMATIC

- MICROLINE -


T-101
V-101 6X4 RECTIFIER
400V
400V
6.3V 1A
R-101 6300
C-101 1 uf
V-102 OB2 VOLTAGE REGULATOR
V-103 OB2 VOLTAGE REGULATOR
R-102 120K
R-103 30K
R-104 510K
C-102-B 1UF
C-102A 1UF
V-104 12AU7 AMPLIFIER
MOTOR-SHADING COILS
RAISE
LOWER
R144 3.3K
K-101 RAISE
K-102 LOWER
R-105 510K
R-106 160K
R-107 75K
R-108 75K
R-109 240K
AC COMMON
T-104
6.3V 3.5A
300V
300V
5V 6A
V-105 6X4 RECTIFIER
L-101 375H
GATE
R-117 470
V-106 12AU7
R-118 470
R-119 51K
AMPLIFIER
C-106 0.1 UF
R-121 100K
R-115 2MEG.
R-116 3.3MEG
V-107A 12AX7
R-120 120K
C-108 1UF
C-104 1 UF
C-105 1 UF
R-122 150K
C-107 0.01 UF
V-108 5651 REFERENCE
R-123 10K
-175 V
C-103 0.02uf
R-111 550
R-112 225
R-113 150
R-114 75
S-104
K-103
S-102-B
* R145
BEAM
S-102A
R-110 750K
K-104
DELAY K-105
CO
OC
S-103
J-101
115V TO BLOWER
AC INSTANTANEOUS
I-101
POWER
S-101
F-101 8 A
J-102
115 V 60 CY INPUT
AC COMMON
B-101
T-102
F-102 8 A.
I-102
T-103
3500V
3500V
RECTIFIER V-109 3B24W
V-110 3B24W RECTIFIER
L-102 6 - 21 H
L-103 12.5 H
C-109 1 UF
1/8 A FAST
F-103
V-111 6L6GA
V-112 6L6GA
GATE
R 124 22
R 125 22
R-128 470
R 127 470
R 126 1 MEG
C-113 200
R-143 10 K
C-110 1 UF
R-129 200K
R-130 150K
AMPLIFIER V 113 12AU7
R-131 68K
AMPLIFIER V-107B 12AX7
R 132 300K
R134 300K
R 133 38.7K
R 135 250K
R-136 250K
R-137 250K
R 138 16.2K
C-111 0.1 UF
C-112 2UF
R142 1 MEG
M-101
M 102
R-139 1 MEG.
R-140 1 MEG.
R-141 1 MEG.
E-101
J-104
-250 V TO -3600V
0 TO -3000V FROM CATHODE
0 TO -1000V FROM CATHODE
E-102 LOW CAPAC CONNECTIO
J-103
AC INST. TO INTERLOCK S-201
COMMON AC INST. FROM INTERLOCK S-201
JUMPER (INTERLOCK BY PASS)
* R145 THIS RESISTOR IS SELECTED FOR CALIBRATION OF OVERLOAD RELAY. THE VALUE SELECTED SHALL PERMIT THE RELAY TO OPERATE ON A VALUE LOWER THAN THE SCALE READING. THIS PART MAY BE OMITTED.
MODEL 555 BEA
- MICR

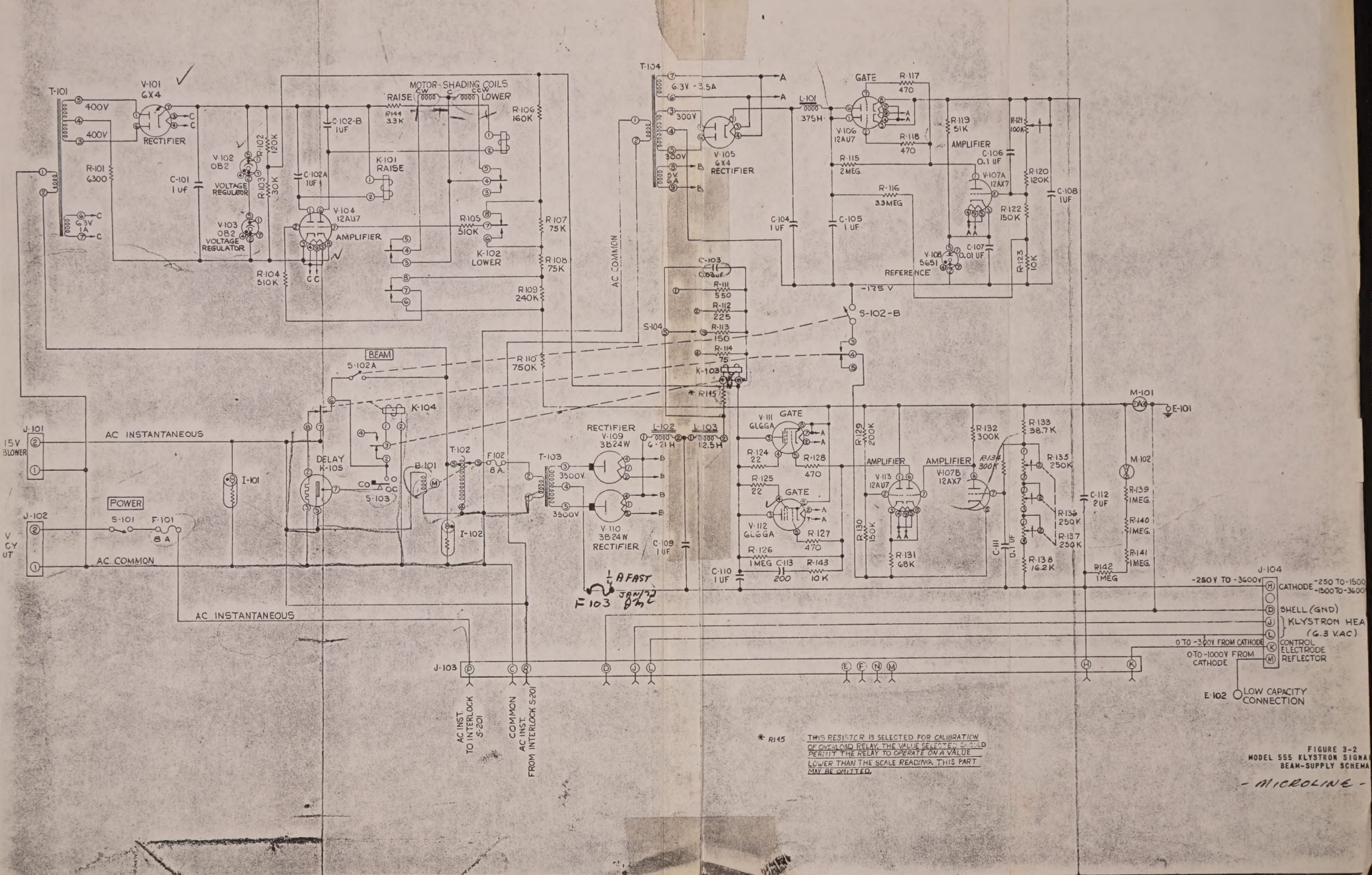


FIGURE 3-2
MODEL 555 KLYSTRON SIGNA
BEAM-SUPPLY SCHEMA

- MICROLINE -

98242